The FOUNDRY

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Castings Determine Strength of Engineering Materials

TODAY, as never before, engineering materials are purchased on exacting specifications which have been developed and adopted by engineering bodies representing industry. Steel, wrought iron, malleable iron, gray iron, nonferrous metals, cement and many other engineering materials must meet definite standards which govern both physical and chemical properties. Numerous tests have been

Castings Are Built Into the Various Types of Strength Testing Machines

developed to reveal the various physical properties of practically every class of material, and where the strength is to be determined, special types of testing machines are employed. Apparatus for testing materials in tension, compression and torsion vary considerably in construction and capacity. Other types of machines are used to determine hardness, resistance to wear and resistance to impact. Through the use of such devices, the engineer determines the suitability of materials for the work at hand and many of the modern engineering developments, such as the skyscraper, are made possible. The foundry industry has rendered a great service to industry as a whole in producing cast parts for the construction of different types of testing machines. Castings are used for this purpose chiefly for their stability, strength, ability to withstand shock and ease of fabrication.

Find Where Castings Can Be Sold.

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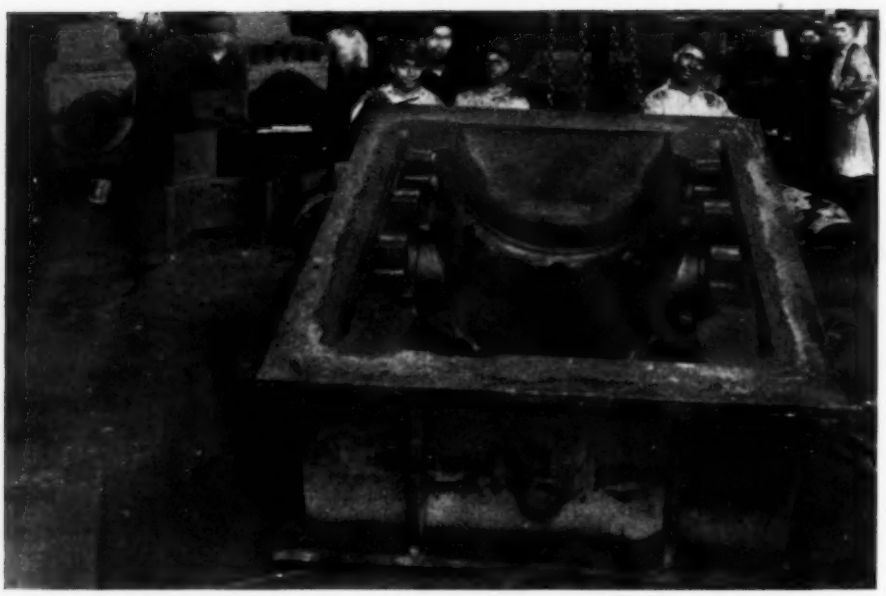


Fig. 1—Drag of Compressor Mold, Finished and Ready for Drying

DEMAND for high quality, uniform products has wrought great changes in methods of production in the foundry industry. This trend has led to the employment of more and more equipment that eliminates as far as possible, the human element. Much advancement in this type of equipment is due to cries for greater production from a given number of men and from a limited floor area. Successful application of molding machines, conveyors, etc., to the specialty foundries has led to the incorporation of some of these ideas in foundries producing heavy machinery.

The old method and one which still is followed in some foundries producing large heavy castings, was to *bed in* all large molds in the floor, employ skilled molders for making the molds, and set most of the cores by hand, using a great many chaplets to support the cores and obtain the proper metal thickness. Now, in many foundries, all molds except those too large to handle are put up in flasks. The sand is rammed on molding machines by semiskilled men, the mold face is finished and blacked by another crew of semiskilled men, and the mold then is oven-dried. Cores for the molds are assembled into one piece by another crew of men and turned over to a gang that places the complete core in the mold and closes the cope.

Sand for the molds instead of being cut over by hand shoveling or by buckets attached to a crane is reconditioned by machinery. It is transported to the molding machines by overhead conveyor belts to hoppers above the machines. By pushing a button or pulling a lever, a sufficient quantity of sand is delivered to the flask and rammed by machine to the proper density. Core sand likewise is mixed by machinery so that the binder employed is distributed uniformly throughout the mass.

The modern foundry of Clark Bros. Co., Olean, N. Y., may be cited as a concrete example embodying the most modern practices. This firm is a manufacturer of air and gas compressors, oil and gas engines, drilling and pumping engines, and heavy, saw-mill machinery. After following the old procedure of bedding in the molds for a great many years, it was decided that more modern methods could be employed to obtain more uniform products, and a larger production from the floor space available.

After some study and effort, the present scheme in force was developed. Essentially it consists in reconditioning the sand mechanically, transporting the sand to the machines on conveyors, machine molding by a molding crew, and finishing and blacking the molds by another group. All large molds are oven-dried. Cores are assembled by a gang devoting its time to this feature, and the

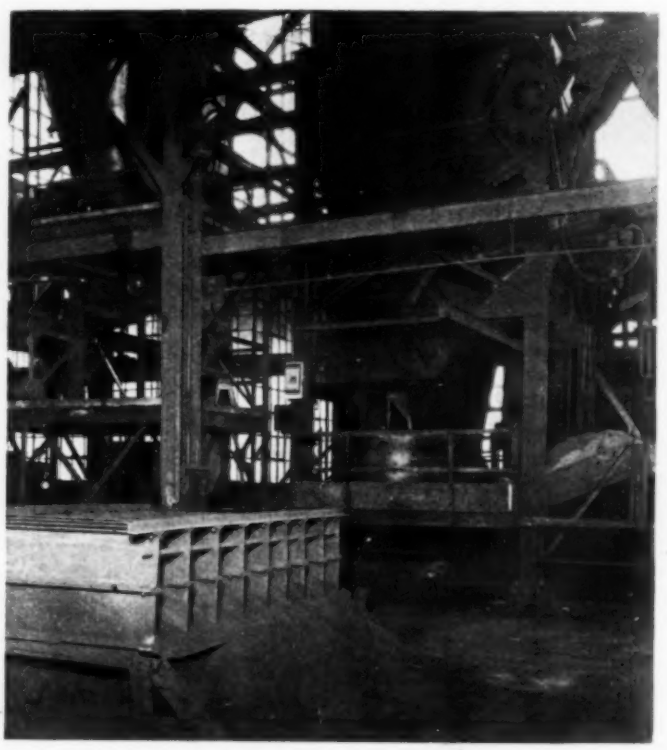


Fig. 2—Molds Are Placed on the Box, and the Jolting Action of the Machine in the Floor Soon Dislodges the Sand

E HEAVY MACHINERY
on Production Schedule

cores are placed in the molds and the molds closed by a fourth crew. The various crews mentioned devote the major part of their time to the work outlined, but they also assist in other operations than their own specialty when work becomes slack.

Sand reconditioning equipment used at the Clark Bros. Co. was supplied by the National Engineering Co., Chicago, and is shown in a number of the illustrations. The shakeout hopper and reconditioning apparatus is enclosed and connected to dust arrester equipment supplied by the Pangborn Corp., Hagerstown, Md. The operations will be described fully to present a clear idea how the sand is reconditioned.

Since the sand molds are dried, dust presented a problem in the shakeout. However, this was overcome by using a plain jolt molding machine manufactured by the Herman Pneumatic Machine Co., Zelienople, Pa., surmounted by a box fabricated from steel I-beams with a sloping bottom. This device is shown in Fig. 2, and the box is removable so that the machine may be used for molding purposes if desired. The box is about 2 x 8 x 10 feet, the sides and partitions are formed by two 12-inch I-beams riveted as may be noted in the illustration. The bottom slopes at approximately 30 degrees, and the box is braced with heavy rods and angle sections.

For use, the box is placed on the jolt machine as shown in Fig. 2, the flask containing the sand is placed on top, and then air is admitted to the cylinder of the machine. In a short time the sand is removed from the flask, and due to the short distance of fall only a small amount of dust is raised. This dust is removed by the powerful suction of the dust arrester, one branch of which is attached to the sand hopper just under the grating.

Sand from the shakeout hopper is elevated on an apron conveyor rising on approximately a 30-

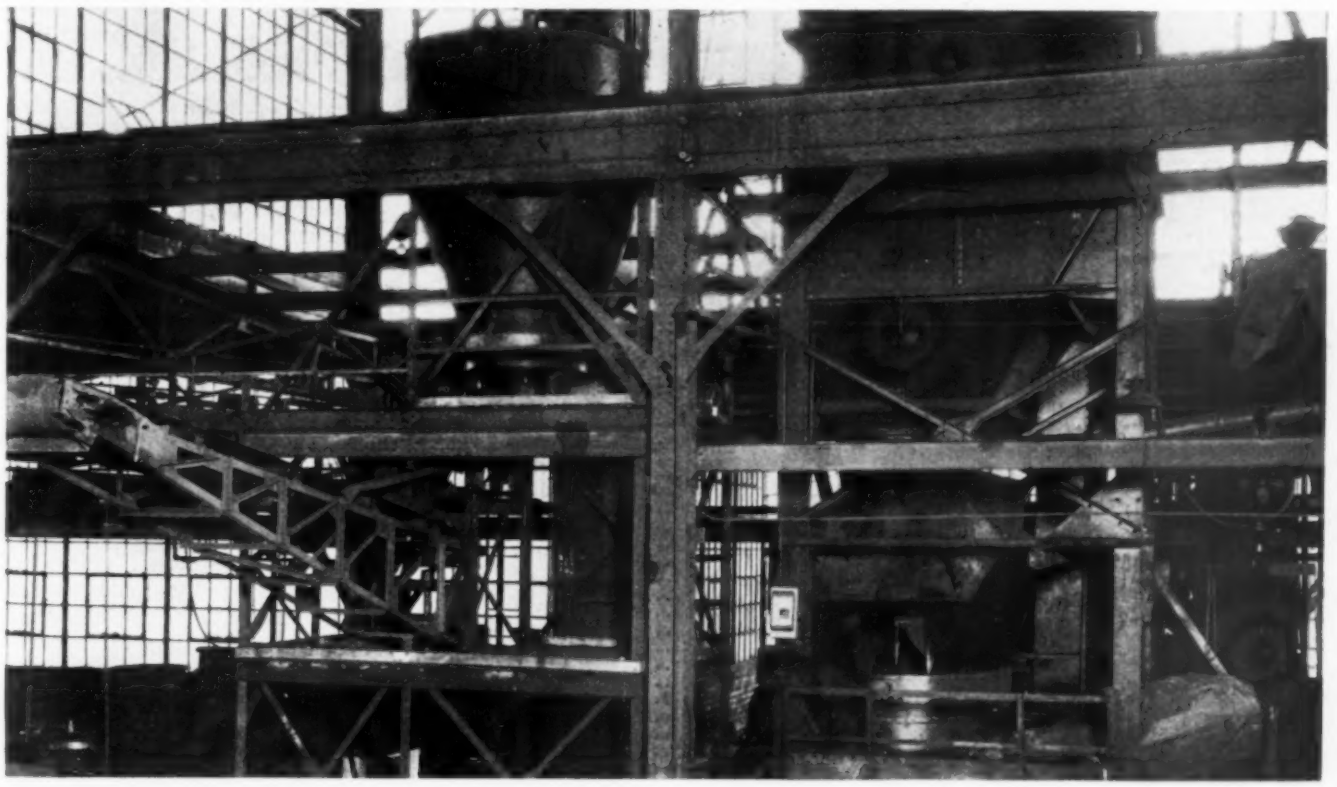


Fig. 3—Dry Sand from the Hopper Is Placed in the Muller Where Water and New Sand Are Added

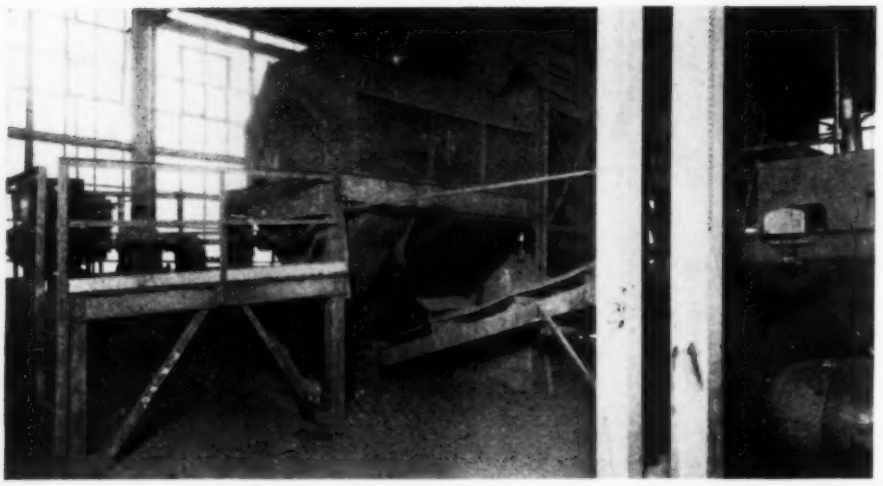


Fig. 4—Enclosed Screen Breaks Up the Lumps and Removes the Gaggers and Large Pieces of Iron

degree angle, to a revolving breaker screen shown in Fig. 4 which breaks up the lumps and removes the gaggers, wedges and other foreign material. The screened sand then is elevated slightly on a belt conveyor to pass over a magnetic separator supplied by the Dings Magnetic Separator Co., Milwaukee, which removes the nails and any tramp iron. The nails are returned to the foundry to be used again, and the tramp iron is sent to the cupola.

Use Batch Mixtures

From the magnetic separator the sand drops into the boot of a vertical elevator which discharges into a storage hopper with a capacity of 100 tons. This hopper, shown at the right in Fig. 3, has a measuring gate at the bottom which discharges approximately 2000 pounds of dry sand into a sand muller also manufactured by the National Engineering Co. From five to eight per cent of new sand is added to the batch to bring the bond to the proper strength. Approximately 13 pounds of pitch is added to the batch, and then sufficient water is added by the attendant to give a moisture content around six per cent. The batch then is mixed thoroughly to incorporate the components, and then dumped into the boot of another vertical elevator.

This elevator discharges into a circular sand bin which has a capacity of 20 tons. This bin is shown at the left in Figs. 2 and 3. The sand bin is emptied by a rotary table feeder either upon a conveyor belt which carries the sand along the side of the main foundry bay to a jolt-rollover, molding machine manufactured by the Herman Pneumatic Machine Co., Zelienople, Pa., or upon a conveyor belt supported on a boom which is used to load the hopper of a tractor type molding machine manufactured by Beardsley & Piper Co., Chicago. The latter is shown in Fig. 7. At several points along the conveyor belt, which travels along the main bay, spouts with deflecting plows are arranged so that sand may be obtained for use on other parts of the floor. Sand from these spouts is run into large scoop-shells attached to cranes which carry it to its destination. Sand tests for permeability, green and dry bond strength, and moisture are made once or twice a week.

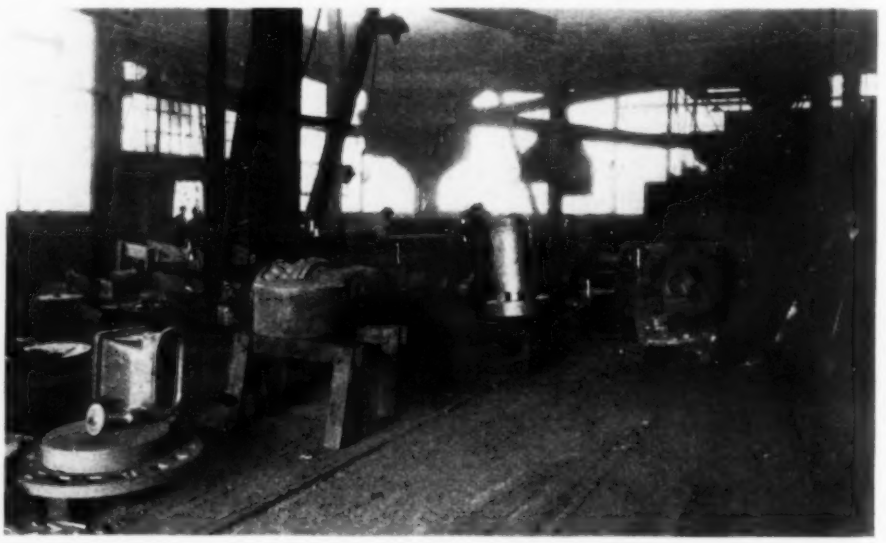


Fig. 6—Chipping and Grinding Are Performed with Pneumatic Tools

Fig. 5—Cores Are Placed on Plates Separated by Cast Iron Blocks

Since most of the molds and castings handled are large, cranes are used for moving the molds around, drawing patterns, core setting, closing the molds, transporting castings and molten metal. Four large cranes are used for these tasks in the main foundry bay of Clark Bros. Co. Three of the cranes were supplied by the Harnischfeger Corp., Milwaukee, and one by the Shaw Crane Works, Mus-

kegon, Mich. The crane runway extends the full length of the bay from the cleaning room at one end to the drying ovens at the other.

As stated previously, molds are made by hand and by machine. Small and medium size castings are molded in green sand on the hand floor or at benches which are situated on either side of the main bay. Cylinders, bedplates, flywheels, cylinder heads and other large castings are made on molding machines consisting of two plain-jolt machines, one jolt-rollover machine, and one tractor-type, sand slinging machine. One of the jolt machines was supplied by the Tabor Mfg. Co., Philadelphia, the other jolt machine and the jolt-rollover machine were made by the Herman Pneumatic Machine Co., Zelienople, Pa., and the sand throwing machine was built by the Beardsley & Piper Co., Chicago.

Flasks used for the molds are made of cast iron and cast in the foundry of the firm. All flasks are ribbed substantially to prevent springing. The smaller sizes are equipped with trunnions and the large ones with side rings for lifting and transportation purposes. Wedge-shaped bars ranging from 2½ inches in the smaller sizes to 6 inches in depth in the larger sizes are cast in the flasks to hold the sand in place. The bars extend the width of the flask on about 6-inch centers, and the length of the flask on 8-inch centers, forming a grating. Besides supporting the sand, the bars eliminate the use of bottom boards on the drag flask.

Earlier in the article it was mentioned that separate gangs were being used in some foundries to carry out the various operations in making molds. This system is employed in Clark Bros. Co. foundry. One molding crew operates the sand throwing machine shown in Fig. 7, which rams the sand in flasks placed on either side of its path. Another crew operates the jolt-rollover machine shown in Fig. 8, which has a slotted bedplate to accommodate clamps for various size flasks. The largest flask the machine handles is 60 x 60 inches. After the molds are rammed, they are picked up by cranes and carried to another portion of the shop.

Here the finishing gangs take charge of the molds. The pattern are rapped sufficiently to loosen them, and then are drawn slowly by the crane. After the pattern is withdrawn, the next operation is to repair any parts of the mold face that may have become broken or cracked. When this is finished, all edges are nailed carefully to hold the sand in position after it is dried, and to prevent the sand from being washed by the molten metal during pouring operations. Runners and branches which later admit the molten metal are cut at this time. Upon conclusion of these operations, the mold is blacked by an air spray. The blacking then is brushed and slicked to give a nice smooth, uniformly coated surface.

The mold is now ready for drying, and is picked up by a crane which transports it to the lower end of the shop containing the drying ovens. The drying department contains five large core ovens, one large mold oven and one drawer-type core oven. All ovens are coke fired. The six large ovens are car charged as may be seen in Fig. 5 which shows a carload of cores ready for admittance to one of the ovens. One of the molds, a compressor air-cylinder, ready for the drying oven is shown in Fig. 1.

When the molds are dried they are removed from the oven, and when cool enough the handle are carried by the crane to the place where they will be poured. The drags are placed on the floor where the core setting crews take charge. While these crews are placing the assembled cores in position, the helpers ram the runner and riser boxes on the copes. These boxes are made in green sand, and all runner boxes contain a perforated piece of metal over the gate which acts as a strainer for the molten metal.

Cores are made in a low bay adjoining the main foundry bay. Sand is mixed in a muller with a batch loader supplied by the National Engineering Co., Chicago. Various kinds of binders are used according to the size and kind of core. Since many of the cores used in the castings produced in the Clark Bros. Co. found-

Fig. 7—A Tractor Type Sand Slinging Machine with a Hopper Makes the Large Molds Placed on Either Side of Its Path. Power Is Supplied by a Cable that Automatically Is Played Out and Wound Up

ry are large, a small electric crane supplied by the Harnischfeger Corp., Milwaukee, is employed for rolling the cores over and transporting them around the coreroom.

Flat steel or cast iron plates hold the cores during the drying or baking operation. In many cases the cores do not have a flat side upon which to rest. Cores of this nature are supported by green sand backings which are rammed on the core in the corebox just before it is turned out on the drying plate. The plates containing the cores are placed on a car as shown in Fig. 5; the plates being separated by cast iron blocks of sufficient height to prevent contact between the cores and plates and to permit heat circulation.

Assembled cores are shown at the left in Fig. 1. These cores are for the bedplates of large compressors which will weigh about 12 tons. As mentioned previously, few chaplets are used, being avoided by designing the cores so that the various parts composing the whole may be pasted and wired together forming a single piece. The single core is supported by a number of bearings or core prints in the mold. As an example, the air cylinder shown in Fig. 1 takes a single core which is composed of 15 parts. This core is supported on 14 bearings in the drag and a like number in the cope prevent the core from floating.

Iron for the castings is melted in either of two cupolas supplied by the Whiting Corp., Harvey, Ill. One of the cupolas is lined to an inside diameter of 66 inches and the other is lined to 52 inches. The smaller cupola is used to melting up to 20-ton heats while the large cupola takes all heats above 20 tons. At present the day's heat averages about 45 tons. Metal charges are composed of steel, machinery scrap, remelt and pig iron.

Clean the Castings

The castings are cleaned at one end of the foundry, a view of which is shown in Fig. 6. A reinforced concrete wall about 12 feet high extending partly across the bay separates the cleaning room from the shakeout and foundry. Three tumbling mills, manufactured by the W. W. Sly Mfg. Co., Cleveland, are used to clean small parts. A large, room-type sandblast machine is used for cleaning the larger castings. The sandblast and the dust arrester used in connection with it also were manufactured by the W. W. Sly Mfg. Co., Cleveland. Pneumatic chippers manufactured by the Chicago Pneumatic Tool Co., New York, are used to remove fins and irregularities. Grinding castings light enough to be handled, are finished on stand grinders while the heavier castings are ground with portable pneumatic grinders manufactured by Rotor Air Tool Co., Cleveland, and the Ingersoll-Rand Co., New York.

Stock materials such as pig iron, scrap, core sand, molding sand, fireclay, etc., are kept in bins in the yard. These bins have concrete floors and are separated from each other by concrete walls. The bins containing materials which will deteriorate in the open are completely enclosed to protect them from the weather. A spur track from the railroad runs along the back of the bins, on an embankment about eight feet higher than the floor of the bins. A locomotive crane is used for unloading materials from the cars to the bins, and from the bins into skid boxes which are transported into the foundry by a gasoline driven, lift truck.

Another interesting feature in practice at the foundry of Clark Bros. Co. is the apprentice system. The firm endeavors to enroll eight apprentices for its training course each year, starting four in January and four in July. The course covers four years and during this time the apprentice spends varying amounts of time in every department associated with the foundry. Each apprentice is required to spend two hours each week in the company school where he receives special training under the direction of a competent instructor.

A definite schedule is mapped out for each apprentice, stating the time he is to spend in each department, and this schedule rigidly is followed. To show the method, one of the schedules that an apprentice now is following may be of interest. This apprentice spends the first three months in helping on dry sand mold-

(*Concluded on Page* 792)

Fig. 8—Cylinders and Other Similar Type Castings Are Made by a Large Jolt Rollover Molding Machine

Definite Procedure

Required in

Etching Iron and Steel

By H. H. Shepherd

METALLOGRAPHIC examination tells a great deal about iron and steel that is not revealed by chemical analysis. Many reagents have been suggested from time to time as suitable for the best etching of specimens for microscopic examination, and since the author has had considerable experience in this field he believes that others may be interested in his procedure. Methods of etching iron and steel will be dealt with briefly, especially the lesser known methods of etching for microscopic examination.

Most Widely Used

A solution of picric acid in alcohol undoubtedly is the most widely used reagent due to the fact that it is, for general purposes, the most convenient and simple reagent to use, and that the results obtained are satisfactory provided the etching has been carried out properly. The general structure of iron and steel (in the case of steel, when in the annealed or normal condition), can be revealed with picric acid etching, so as to give micrographs of excellent clearness of detail. Some metallographists and metallurgists prefer the use of nitric acid solutions, but it is the author's experience that generally speaking, this reagent is not as satisfactory as picric acid. The etching action is more coarse and tends to be uneven. Unless the operator has had considerable experience in the use of nitric acid, the etching is apt to be quite coarse. However, it is necessary to point out that the above statements regarding the use of nitric acid, only apply to the full, in the case of steels, when in the normal condition. Hardened carbon steels and some alloy steels can be treated satisfactorily with nitric acid. In fact it is a valuable reagent for this class of material.

A 5 per cent solution of picric acid in alcohol gives good results for the following materials; the figures shown in brackets indicate approximately the length of time required for etching:

> Wrought iron (20-30 seconds), mild steel (15-20), carbon steels in the annealed condition (15-20), white cast iron (10-15), malleable cast iron (5-7), gray cast iron (20-30).

The chief difficulty to be contended with in the use of picric acid is the tendency for stains to form on the specimen. If the following procedure is adopted, it will be found that staining is reduced to a minimum:

> Hold the specimen in the forceps made of iron or steel. A clean pair of iron or steel crucible tongs are useful for this purpose. Immerse the specimen in a vessel containing sufficient reagent to cover the specimen completely immediately upon immersion. From the time of immersion to the moment of removing the specimen from the solution after etching, keep the specimen in constant but gentle motion without allowing its surface to become exposed to the air. After etching rapidly transfer the specimen to a dish containing plenty of warm water, and wash well. Then remove the specimen and wash with alcohol. The most economical means of using alcohol for this purpose is to employ the use of a small wash bottle, fitted with a small jet. Evaporation of the spirit is prevented by fitting the jet and mouthpiece ends of the bottle with pieces of rubber tubing, the one end of each piece being stopped with a bit of glass rod. After the specimen has been washed with alcohol, dry it by a cold air blast. A foot blowpipe will do this admirably. Then rub the specimen lightly upon a piece of clean chamois leather. It is then ready for examination under the microscope. If some slight stains are noted on the specimen, rub it gently on a piece of chamois leather which has been moistened previously with a little rouge. A pad which is soaked thoroughly in rouge should not be used for this purpose, as invariably it destroys the fine detail of the etching.

Figs. 1 and 2 illustrate results obtained by etching cast iron in picric acid according to the procedure just described. Both micrographs were taken at a magnification of 100 diameters. Fig. 1 is that of a section of an ordinary gray cast iron taken from a medium weight casting. Fig. 2, that of a section of cast iron scrap, high in phosphorus. This element is present to the extent of more than 2 per cent. In Fig. 1, the phosphorus content is nearly 1 per cent.

Stead's phosphorus reagent is made and used as follows:

> Dissolve in the least possible quantity of hot water 2.5 grams of cupric chloride ($CuCl_2$) and 10 grams magnesium chloride ($MgCl_2$). Add to the solution 5 cubic centimeters of concentrated hydrochloric acid; then dilute the whole to 250 cubic centimeters with alcohol.

Deposits Copper

Utility of this reagent depends upon the fact that when a specimen is treated with it, copper is deposited from the solution on the specimen. The deposit occurs first and heaviest upon the purest portions of the metal, and then continues to deposit upon the other portions in order of their purity.

The specimen must not be immersed in the solution. To etch the specimen, cover it with a layer of the reagent, and allow this to remain for one minute. Shake this off and apply a second layer and leave for the same period. This operation should be repeated until the deposits of copper are definite; two or three minutes treatment is usually sufficient. Too long a treatment is apt to confuse or even completely spoil the effects, since the copper deposits on areas of the specimen in order of their pureness until the whole surface is covered. Consequently, too long a treatment considerably interferes with the delicacy of the test. However, if the phosphorus is high in parts or throughout the whole of the material, a copper deposit may not be secured on these parts, or on any portion of the specimen even after it has been

treated many times with the reagent. After treatment, the specimen is washed well with hot water and finally with alcohol and dried in an air blast.

Stead's phosphorus reagent is valuable to the metallographist as its use forms an ideal means of detecting phosphorus segregation in iron, especially in wrought iron and steel. It is true that picric etching will, in the cases of wrought iron and mild steel sometimes reveal marked phosphorus segregations, but the indications are not absolute. That is to say, segregated phosphorus in these materials often is indicated by bands or patches of crystals which are much larger than the normal sized crystals of the materials. These indications are likely to be misleading, especially if the specimens under examination are portions of an actual forging or stamping, as the variations in crystal size may be due to the effects of high temperatures in the manufacture or heat treatment. Stead's reagent gives positive results. Fig. 3 illustrates a result obtained by the application of this reagent to a sample of wrought iron. The micrograph is that of a transverse section of a bar of this material which failed to cold bend satisfactorily due to high and segregated phosphorus. The segregated areas of phosphorus clearly are shown as bright (white in the micrograph) bands extending across the specimen, where the copper had failed to deposit.

Hardened Carbon Steels

A 5 per cent solution of nitric acid in alcohol is a good etching reagent for hardened carbon steels. It will reveal the general structure, showing martensite, and martensite-troostite structures clearly. The period of etching ranges from 3 to 7 seconds. Troostitic steels require the shorter time as troostite etches and darkens quickly. Hence, short etchings are advisable. Unfortunately, such short etchings do not reveal the martensitic structure well, and etching periods of 5 to 10 seconds are necessary. Martensitic structures require rather high power magnification, 500 to 600 diameters to reveal the true structure as martensite is often fine enough to appear almost amorphous.

This reagent which should be prepared immediately before use and not kept in stock, is prepared by mixing 1 part of amyl alcohol, 1 part of ethyl alcohol and 1 part methyl alcohol, with 1 part of a 4 per cent solution of nitric acid in acetic anhydride. To somewhat simplify the making of the reagent the author uses three parts of ethyl alcohol (absolute alcohol); 2 parts of this replacing the methyl and amyl alcohol. This can be done without materially affecting the efficiency of the etching reaction.

Gives Etching Time

The specimen is immersed in this solution for 45 to 75 seconds according to the composition and heat treatment the steel has received. The length of time required to secure the most satisfactory etching is of course, found by experience.

Figs. 4 and 5 are micrographs of a section of a hard, but not tempered, steel valve strip taken from a hydraulic pump cylinder. The sections were etched for one minute in Kourbatoff's reagent. The magnifications were 95 diameters in each case. Fig. 4 is a micrograph of the surface of the strip; Fig. 5 that of the edge of the strip. These show clearly that feathery structure so characteristic of martensite, at such magnifications.

We may now consider the etching of alloy steels, especially those known more commonly by the term *high speed steels*, with which the author has had considerable experience. The following notes may be useful to those interested in such steels and particularly those to whom association with such material is new.

Picric acid is useful for etching of the annealed or normal alloy steel. It is unsuitable for the etching of the hardened steel. The time required for etching is much longer than that required for an ordinary carbon steel. To speed up the etching reaction Yatsevitch recommended the addition of 20 per cent water to the alcoholic solution of picric acid. That is a solution consisting of 5 per cent picric acid, 20 per cent water and 75 per cent alcohol. The procedure for etching is similar to that described for wrought iron, mild steel, etc., except that the etching period may range from 5 to 7 or 8 minutes. The results of picric acid etching, is that of revealing the free carbide as bright nodules or masses against a dark matrix background.

A 10 per cent solution of nitric acid in alcohol is a valuable reagent for the etching of hardened alloy steels. The time of etching varies from ten to 15 minutes. Procedure is as described for etching by picric. Such nitric acid etching reveals clearly, the crystal structure of hardened materials.

Use Fresh Reagent

Yatsevitch's reagent which can be used for the etching of either the annealed or hardened steel, is made and used as follows:

To every 20 cubic centimeters of 10 per cent solution of sodium hydroxide (NaOH) required to form nearly sufficient volume (two-thirds of solution for etching) add 10 cubic centimeters of hydrogen peroxide. The solution should be made fresh the day it is used. Immerse the specimen for 10 to 12 minutes then wash, first with water, then twice with alcohol, and dry by air blast.

FIG. 1—SECTION FROM A MEDIUM-WEIGHT GRAY IRON CASTING WITH ABOUT 1 PER CENT PHOSPHORUS PRESENT. FIG. 2—SECTION OF A PIECE OF CAST IRON SCRAP CONTAINING OVER 2 PER CENT PHOSPHORUS. BOTH SPECIMENS MAGNIFIED 100 DIAMETERS. FIG. 3—MICROGRAPH OF A SECTION OF A WROUGHT IRON BAR USING STEAD'S REAGENT

Time required for etching when using Yatsevitch's reagent varies little, whatever the condition of the steel; that is annealed or hardened. In the cases of picric acid and nitric acid the time required rapidly increases as the temperature at which the steel has been treated and the rate of cooling increases.

The reagent of Yatsevitch reveals free carbide, that is, the carbide containing tungsten, clearly in both the annealed and the hardened steel. The free carbide appears as dark nodules or masses against a white background in the case of annealed specimens, and in that of hardened specimens any free carbide is shown as dark envelops or skeleton-like lines against a light background.

Shows Free Carbide

Yatsevitch's solution forms an excellent means of detecting free carbide, especially in the heat-treated material, and for this purpose it is certainly the best reagent the author has used. However, it does not reveal the polyhedral structure of the heat-treated material as does nitric acid. For that reason the author's general procedure for the micro examination of such material is to use Yatsevitch's reagent for the annealed steel and also for the hardened steel. The latter being followed if necessary, by examination of a specimen etched with HNO_3, so as to enable the crystal structure to be judged.

It may be mentioned here, that the presence of a small amount of free carbide, in some cases, in the hardened steel, is not detrimental to the steel. Some authorities consider that such small amounts actually improve the cutting properties, but there is no doubt that, since free carbide is brittle and settles between the crystal boundaries, any considerable amount is deleterious to the steel. It renders it brittle and causes splitting and flying of the tools.

It has been stated previously in this article that an alcoholic solution of picric acid is a satisfactory etching reagent for cast iron. Etching with this reagent reveals the general structure, or at least that which is usually regarded or referred to as the general structure. This includes graphite size and arrangement, phosphide constitution and distribution, and also manganese sulphide. Few micrographs of gray cast iron reveal the pearlite. This is due no doubt to two causes, namely the difficulty of etching such iron to show the pearlite satisfactorily, and the lack of attention to the importance of the character and distribution of pearlite in gray cast iron. The first is the chief cause, and the second cause no doubt is brought about to a large extent, and is interdependent upon Cause 1.

Investigates Etching Reagents

To ascertain the formation and distribution of the pearlite in certain types of castings, the author conducted experiments with various etching reagents, with the view to obtaining an etching result which would give the complete general structure, including pearlite. The method to be described is the one adopted as giving the most satisfactory results. It may be mentioned that the author tried the use of one etching solution only, to give the required results, namely the copper ammonium chloride solution. However, the results were unreliable but the experiments are continuing with the hope of securing a one solution etch.

A 50 per cent solution of picric acid in alcohol and a solution of copper ammonium chloride made as follows are used:

Cupric chloride ($CuCl_2$).....8.5 grams
Ammonium chloride .....5.3 grams
Hydrochloric acid (conc)....2.5 cc.

Dissolve these in the least possible quantity of water, then make up the solution to 100 cubic centimeters with alcohol. There should be at least 80 cubic centimeters of alcohol present. If the amount of water used for dissolving the salts is too great, the etching reaction will be rapid and the specimen will become heavily coated with copper and deeply pitted. The graphite and phosphide structure will be destroyed.

Etch the specimen for 10 to 20 seconds, the length of time varying according to the type of iron under examination; a close grained cylinder iron usually requires fully 20 seconds. The etching is carried out as already described for picric acid. After washing, dry and rub lightly if necessary on the rouge pad to remove any stains. Immerse for 20 to 30 seconds in the copper solution. Then remove the specimen and wash it well with alcohol only. If the specimen appears stained, which is rarely the case, as the reagent etches slowly, polish lightly on chamois leather moistened with a little rouge solution.

A further point of advantage arising from this copper ammonium chloride etching is that the manganese sulphide is etched, or rather assumes a definite blue color, making it readily

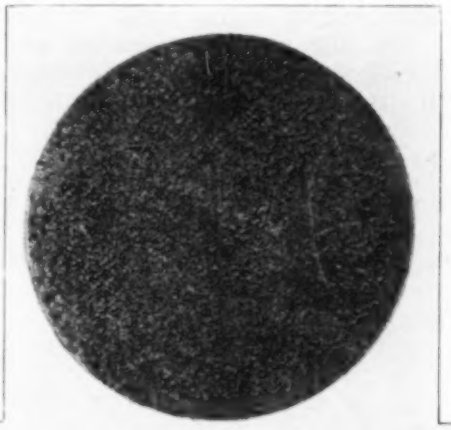


FIG. 4—TOP CENTER—SURFACE OF A STEEL VALVE STRIP. FIG. 5—BELOW—SAME AS FIG. 4 EXCEPT TAKEN AT THE EDGE OF THE STRIP. BOTH MICROGRAPHS AT 95 DIAMETERS

FIG. 6—LOWER CENTER—SPECIMEN CUT FROM A REJECTED LOCOMOTIVE CYLINDER. FIG. 7—BELOW—SECTION OF MOTOR CYLINDER CASTING SHOWING DETAIL OF STRUCTURE

distinguishable to the eye, when examining specimens microscopically.

Fig. 6 illustrates an example of etching by the method just described. The specimen was cut from a rejected locomotive cylinder casting of foreign make and having the following approximate analysis: Total carbon, 3.5 per cent; combined carbon, 0.5 per cent; silicon, 2.4 per cent; sulphur, 0.15 per cent; manganese, 0.5 per cent; and phosphorus, 0.5 per cent. The micrograph, which was taken at 100 diameters, shows clearly the general structure of the iron.

Fig. 7 is a further example, the specimen being taken from a motor cylinder casting possessing a close fracture and the following approximate composition: Total carbon, 3.2 per cent; combined carbon, 0.6 per cent; silicon, 1.75 per cent; sulphur, 0.10 per cent; phosphorus, 0.86 per cent, and manganese, 0.85 per cent. Magnification equals 100 diameters.

In this case also, the general structure is plainly shown, but the detail of the structure of the pearlite is not revealed owing to its size. Its distribution is clear and interesting, as it reveals in some measure the physical properties of the material. If this is examined at some distance from the eye, it will be noticed that the pearlite formation is chiefly of a dendritic nature. This type of formation is indicative and characteristic of strong close grained iron. Further examination will show that fine *rivers* of phosphorus lie in the ferrite and between the pearlite masses, and present a network appearance.

It may be mentioned in conclusion that the author is, from experience, strongly of the opinion that manganese materially aids this dendritic arrangement of the pearlite and the network formation of the phosphide. While in castings containing only about 0.5 per cent manganese these conditions are not so evident, in castings containing 2.0 per cent manganese, the other elements remaining standard, they become marked.

British Discuss Die Casting Alloys

THE twentieth annual autumn meeting of the British Institute of Metals was held at the Adelphi hotel, Liverpool, Sept. 4 to 7. Dr. Walter Rosenhain, president of the institute and head of the metallurgical department of the National Physical laboratory, presided. Fifteen papers of a scientific and practical character were submitted for discussion and R. May, investigator for the committee on corrosion research, presented the eighth report of the committee. Three of the papers of particular interest were on die-casting alloys.

R. Genders, R. C. Reader, and V. T. S. Foster, research department, Woolwich arsenal, presented a paper on the "Die-Casting of Copper-Rich Alloys." They stated that an explanatory examination of a wide range of alloys in the form of chill cast bars and die-cast test pieces has indicated that a variety of alloys exist, suitable for die-casting and offering a wide range of mechanical properties. The aluminum brasses which were examined in greater detail had advantages in their range of properties, high proof stress, slow rate of attack of the mold and core materials, and cheapness. Mold and core materials were tested by immersion in molten alloys at rest and in motion. The phosphorus content of cast iron was found to influence its behavior when immersed in molten aluminum bronze.

A paper on the "Properties and Production of Aluminum Alloy Die-Castings" was prepared by S. L. Archbutt, J. D. Grogan, and J. W. Jenkin, of the National Physical laboratory, Teddington. Five aluminum alloys were employed in the study of die-casting—namely, 4 per cent copper, 8 per cent copper, 12 per cent silicon, 4 per cent copper plus 3 per cent silicon and Y alloy. Difficulties due to air locks, shrinkage, sticking of cores, etc., were at first encountered, but by careful control of such factors as mold and metal temperatures, rate of pouring, etc., the difficulties were overcome and considerable success attained with all the alloys. The second part of the paper dealt with the question of the hot-shortness of aluminum die-casting alloys, and it was found that as far as the alloys studied are concerned hot-shortness is only exhibited at temperatures close to the temperature at which melting begins.

The third paper on die-casting was by T. F. Russell, W. E. Goodrich, W. Cross, and N. P. Allen of the metallurgical dept., University of Sheffield, on "Die-Casting Alloys of Low Melting Point." Sixteen zinc-base alloys were studied. In this case pressure-cast flat test pieces were made and examined for tensile strength, hardness, bending strength, and porosity, with special reference to the influence of mold and metal temperature, the size of gate and vent, and the type of pull on the lever of the machine. It was found that the porosity depends almost entirely on the pull of the lever, and that the difference due to the kind of pull becomes less as the gate is opened.

In opening the discussion on these papers Dr. Rosenhain pointed out that the object of the various investigations was the study of the die-casting alloys themselves, and he thought that a valuable contribution had been made on the subject. However, there still remains the important question of mold and core materials, for if die-casting is to be an economic success it is necessary to have mold and core materials that stand up. J. G. Pearce, director of the British Cast Iron Research association, emphasized the lack of information on mold materials. He was of the opinion that some of the heat-resisting irons would be suitable, due to the success that had attended their use in the cast iron industry. J. Cartland confirmed the authors' statement regarding the control of the various factors in the case of the aluminum alloys. He also said that he found it necessary to adopt trial and error methods with every new casting, but once the correct conditions have been determined, any number of further castings can be made without any trouble. A number of other members contributed to the discussion.

An interesting paper on "Practical Pyrometry" was presented by G. B. Brook and H. J. Simcox, British Aluminium Co. Ltd. A millivoltmeter designed to eliminate the effect of stray current and magnetic fields of great intensity, which are peculiar to industries employing large currents, is described. Tuesday evening, Sept. 4, the seventh autumn lecture was delivered by F. G. Martin, on "Non-Ferrous Metals in the Shipping Industry."

In addition to the business part of the meeting, an interesting social program was arranged by the local reception committee, of which C. O. Bannister, professor of metallurgy, University of Liverpool, was chairman. The program included works visits, luncheons, dances, and a reception at the town hall by invitation of the Lord Mayor, Miss Margaret Beavan. The meeting concluded with a motor coach tour through North Wales, during which members had an opportunity of visiting the works of the British Aluminum Corp. at Dolgarrog.

STEEL FOUNDRY

Operates an Extensive

Research Laboratory

By W. C. Hamilton

DURING the war, the American Steel Foundries operated a forge plant on their property at East Chicago, Ind. All of the buildings now have been dismantled with the exception of the power house, a part of which has been remodeled to house a research laboratory. This building, due to its rigid construction and general dimensions, has proven ideal for the purpose. The massive foundations allow the operation of exceptionally delicate equipment without the usual annoyances from vibration. The building is 36 feet wide and 320 feet in length, only one-half of the length being occupied by the research laboratory. The other half contains the record storage.

The laboratory is divided into several departments. The work room covers a space 36 by 80 feet, the chemical laboratory a space 20 by 40 feet with a balance room 12 by 20 feet, and the metallographic room a space 9 by 19 feet. In addition, there is a dark room, a library and two large offices, together with wash rooms.

The following equipment has been installed:

High frequency induction furnace made by the Ajax Electrothermic Corp., Trenton, N. J.

Industrial gas furnace with automatic control supplied by the Chicago Flexible Shaft Co., Chicago.

Two furnaces with automatic control built by the Leeds & Northrup Co., Philadelphia.

Dilatometer and coefficient of expansion furnace supplied by Wilson-Maulen Co. Inc., New York.

Critical temperature instrument built by the Leeds & Northrup Co.

Endurance testing machine developed by R. R. Moore.

Impact testing machine and tensile machine, 100,000 pounds capacity, built by Riehle Bros. Testing Machine Co., Philadelphia.

Scleroscope built by the Shore Instrument Co., Jamaica, N. Y.

Brinell hardness testing machine built by Tinius Olsen Testing Machine Co., Philadelphia.

Hardness testing machine supplied by Wilson-Maulen Co.

Two wear testing machines.

Metallographic outfit (with lenses good for a visual magnification up to 2500 diameters and a photographic magnification up to 10,000 diameters.

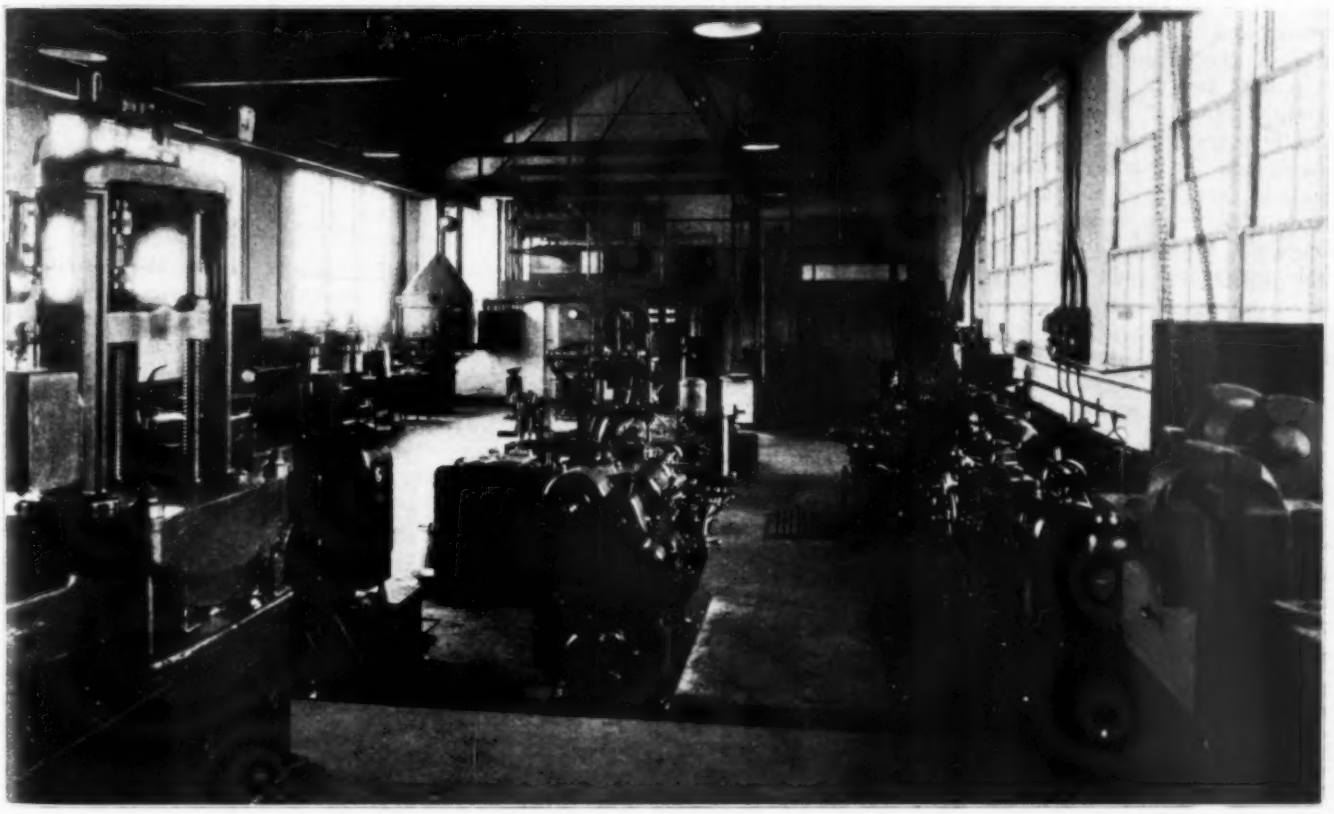


FIG. 1—GENERAL VIEW OF THE RESEARCH LABORATORY WORK ROOM SHOWING THE VARIOUS PIECES OF APPARATUS

There is also a special lens for macrostructures from normal size to a magnification of eight diameters).

Polishing equipment for microscopic work.

The machine shop is equipped to take care of the work necessary in the preparation of the different test specimens. A number of accompanying illustrations show certain equipment and its arrangement.

The library is being furnished gradually with the latest technical books and in addition there are the proceedings of various technical societies together with the issues of several industrial magazines of interest. A complete set of the publications of the bureau of standards is considered an extremely valuable asset to the library.

The high frequency induction furnace has proven an ideal one in which to make small heats of ferrous alloys. Recently an article in an English paper described a method of making steel by radio in a wooden box which was a reference to a high frequency induction furnace.

A motor-generator set furnishes single phase power at 960 cycles and 900 volts. This voltage is impressed on a water-cooled copper coil of about 50 turns which acts as the primary circuit of a coreless transformer. A crucible containing the charge to be melted is placed within this coil. Any electrically conductive material charged in the crucible acts as a short-circuited secondary of the transformer and absorbs the inductive energy of the primary coil, converting it to heat energy. The normally low power factor of such an inductive load is corrected by a bank of static condensers. It would be entirely practical to have the coil and crucible surrounded by a wooden box. The similarity to radio is only because a high frequency induction current is used.

Crucibles made of graphite, magnesia and silica are practical, but for the melting of various alloys of steel, the silica crucibles have proven most satisfactory. Between the silica crucibles and the coil carrying the current, ordinary silica sand is packed. The silica crucibles nearly always develop cracks which are almost immediately sealed by the slag, and the steel with a higher surface tension has not been known to penetrate through. Moreover, the crucibles are fluxed away making the walls thin at places, but the sand back of these spots fuses together making an effective patch as good as the original wall.

It is possible to make from 12 to 15 heats in a silica crucible before it is discarded, equivalent to about 1000 pounds of metal. The crucibles cost $5.80 each, or $11.60 per ton of steel melted. Less than 25 minutes is required to make a 65-pound heat and one of 140 pounds can be made in less than one hour. The current used is approximately 40 kilowatt hours per 100 pounds of steel melted, equivalent to 800 kilowatt hours per ton. At a cost of 1.1 cent per kilowatt hour this current consumption is worth $8.80 per ton of steel melted.

Outlines Procedure

IMPORTANCE of the research laboratory to the iron and steel industry as a whole and the foundry industry in particular, is recognized by all. The past decade has seen many new laboratories established and it is probable that much attention will be paid to this field in the future. For that reason, it is of interest to the industry to learn of the methods and equipment employed in the research laboratory of a large midwestern steel foundry. This article is abstracted from a paper presented at the Philadelphia convention of the American Foundrymen's association. The author is research director, American Steel Foundries, Indiana Harbor, Ind.

With the renewal of crucibles when necessary this furnace is always ready for use. It is simple to run and there is no dirt connected with its operation. There is no contamination of the charge except by a fluxing of the silica from the crucibles and the temperature of the molten metal is under control by changing the current. Another important factor is the agitation given the molten mass due to the induction current. This motion gives a thorough mixing of additions almost as soon as they are melted. In making ferrous alloys, the charge used is either boiler punchings or commercially pure iron, depending on how low a sulphur and phosphorous content is desired. The steel melted is poured into sand molds designed to give test specimens. It is possible to obtain sections 6 inches in cubical size to study the influence of mass on the subsequent heat treatments and resulting physical tests.

Heat treatment of the tests is carried out mostly in the furnaces built by the Leads & Northrup Co., although the gas furnace is used when temperatures over 2000 degrees Fahr. are desired. It is, of course, desirable to obtain the critical temperatures of the different compositions before the steel is heat treated.

The Leeds & Northrup Co. instrument is satisfactory in these critical temperature determinations, but there are certain compositions which do not give a sharp Ac_1 point with our use of this instrument. A dilatometer supplied by the Wilson-Maulen Co. has proved a valuable help. This instrument is installed to be used either in connection with a small furnace heating tests 1 by 3 inches or in connection with one of the Leeds & Northrup Co. furnaces heating large sections.

In the small furnace, it is expected that we will be able to obtain the coefficients of expansion but so far our work has been limited to the matter of obtaining the temperatures at which the steels start to contract in heating, which temperatures are the beginnings of the Ac_1 ranges. The end of this contraction, which is the last of the Ac_1 range is of course noted. The same is done in the expansion during cooling, and the total ranges of contraction in heating and expansion in cooling give the information of greatest value in heat treating.

In addition, the Leeds & Northrup furnaces give a break in the charts as the steel passes through the critical temperatures. The temperature of these breaks on the pyrometer charts indicate where the decalescence begins in heating and where the recalescence begins in cooling, and it is entirely practical to heat a bar of steel in the furnaces without first obtaining the critical points and by watching the pyrometer chart know approximately when the heating is high enough for proper refinement.

The furnaces are well suited to the drawing of specimens, as they can be controlled automatically to any temperature up to 2000 degrees Fahr. Chromel-alumel couples are used in these furnaces. Automatic attachments have been added whereby either a bell is rung or the power is shut off after a certain period. By this arrangement, a long test may be stopped on the night turn with no supervision.

The machine shop has the equipment necessary to prepare test specimens, starting with coupons or large castings. No machining is done by piece work as quality is the essential thing in test specimens which will be used in carrying on research work.

A grinder made by the Heald Machine Co., Worcester, Mass., with a magnetic chuck to hold specimens is useful in the preparation of parallel surfaces with a smooth finish to be used for hardness testing and macrograph examinations.

The endurance machine has not been employed to obtain the endurance limit of steels. This investigation requires too long a series of tests to be practical using only one endurance machine. So far the endurance tests have been made with a load of 55,000 pounds per square inch, this load being above the endurance limit of the steels tested but below the elastic limits. In this way a test is made in from one to ten hours, depending on the number of revolutions necessary for fracture of the piece.

The pull tests are made on standard two inch bars, the stress strain diagrams being obtained by the autographic attachment and their interpretation is made by the Johnson method.

In addition quick tests on bars maintained at high temperatures are being made with a measurement of the extension and permanent set for different loads.

Wear testing determinations made with the machines presented many problems before satisfactory results were obtained.

Specimens 1¾-inch in diameter with a width up to ⅜-inch are used. One specimen revolves at a speed of 10 per cent less than the other when the diameters of the two specimens are the same, so that a slippage between the specimens is maintained. In our work so far, one specimen has been made of a definite composition at a definite hardness, this hardness being greater than the hardness of any of the specimens under investigation. The hard standard is run at the faster speed and as the specimen, under test wears away, the reduced diameter results in a greater difference in the peripheral speeds of the two specimens. This arrangement of course exaggerates the wearing conditions of a metal that does not resist wear. In other words, a specimen that starts to wear rather decidedly with a 10 per cent slippage will wear more rapidly as this slippage increases, due to the wearing and consequent reduction in diameter of the specimen.

In addition to the slippage an adjustable lateral motion is given to the specimens as desired and it is also possible to give a bumping action to the specimens. There is also an attachment whereby the friction between the two specimens may be measured. This attachment is especially important when bearing metals or lubricants are under investigation.

The machines as delivered are equipped with a spring attachment whereby the load is applied to disks 1¾ inches in diameter revolving against each other in opposite directions and running at a speed of approximately 10,000 revolutions per hour. As the specimens wore, the tension on the spring became less and therefore the load could not be maintained constant. A floating load hanging on springs has been substituted with good results.

However, the most annoying obstacle has been the formation of iron oxide on the wearing surfaces, especially when the tests are over rockwell-"C" 45. The oxide acts as a lubricant, preventing natural wear. Fans were installed to cool the specimens and the blast of air removes much of the metal as it is worn into a powder. Nevertheless there is a skin heating due to the friction and a formation of iron oxide with which to contend.

When the wearing action is rapid the worn metal and oxide do not adhere to the specimen. In this case the worn particles are of a flaky nature and are blown away by the fan. On the other hand, when the wear is slight the few particles formed are of microscopic size and hence are changed more readily to iron oxide which forms as a glaze on the specimen.

The bureau of standards has reported this difficulty and has used a strip of copper pressed against both the specimens to remove this glaze of iron oxide, with more or less success. In our work we have avoided placing any material against our specimen under test but have used both copper and spring steel in contact with the standard. In every case the prevention of the oxide glaze on the standard insures no glaze on the softer specimen being tested. The spring steel has been found more efficient than the copper, but whatever is used must make perfect contact with the periphery of the standard specimen. However it is more practical to increase the load as the resistance to wear increases so that an appreciable wear is obtained; thereby preventing the polishing of the specimen.

The load and number of revolutions in use were decided upon after a number of preliminary tests under different conditions. The load per square inch is not known, as we do not know the area of contact between

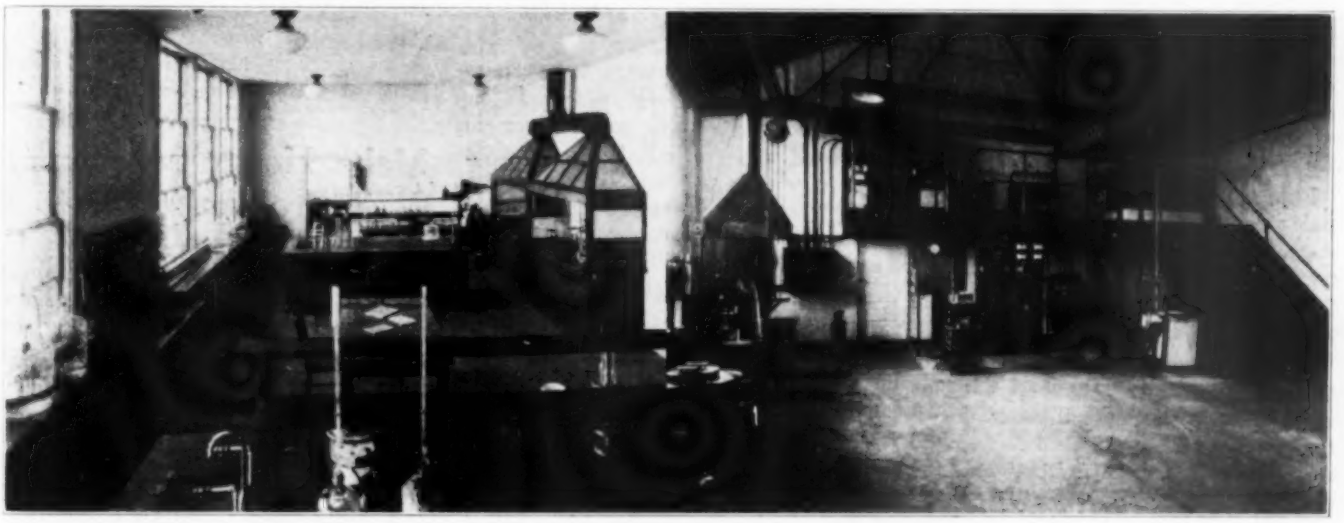


FIG. 2—CHEMICAL LABORATORY OF THE RESEARCH DEPARTMENT. FIG. 3—VARIOUS TYPES OF FURNACES ARE USED FOR HEAT TREATING AND MELTING

the two disks. It was found that certain loads distorted the metal too severely and we finally decided on a load of 50 kilograms and 50,000 revolutions for specimens up to a hardness of rockwell-"C" 45. The specimens weigh 65 grams and the test results in a loss of 4 grams or 6 per cent as a maximum, the time required being slightly less than 5 hours. Greater loads of course, are necessary under certain conditions. Attachments have been made whereby the machines are stopped automatically after the desired number of revolutions have been made.

Wearing properties of steel are being investigated in reference to composition, microstructure, and hardness obtained by different methods of heat treating.

Metallographic Work

The metallographic work being done on steel may be divided into three classes:

First.—Photomicrographs from normal size to a magnification of eight diameters. This work deals with the casting structures in connection with dendrites and imperfections visible to the naked eye.

Second.—Photomicrographs at a magnification of 100 diameters. This work covers the detection of inclusions and microscopic defects and also the general structure of the steel.

Third.—Photomicrographs at a magnification of 1000 diameters. This work covers the identification of the impurities and constituents present and this statement may well be modified to an attempt at these identifications.

In this attempt a magnification higher than 1000 diameters often is necessary. It is felt that a good method for the identification of impurities is lacking, and on account of the complex nature of these impurities it seems that the chemist and metallographists must work hand in hand.

To interpret the constituents of steel and their relative forms, it too often is necessary to inquire what treatment had been given the steel under examination. What gives to steel the property to harden is still a much discussed question and it has been predicted that the x-ray will some day solve the problem. However much can be learned by a study of steel at high magnifications under the microscope and in our research laboratory this study is receiving considerable attention.

The chemical laboratory was built sufficiently large to take care of work of various natures, but so far the work has been mostly analytical.

The work undertaken up to the present may be outlined as follows:

1. Production of alloy steels.
2. Chemical analysis.
3. Heat treatment.
4. Machine work.
5. Physical testing.
6. Metallographic examination.

In addition, steel in various forms has been sent in from our different works to be examined.

The equipment necessary for the above work has been placed in charge of different men, mainly to insure its proper maintenance. The organization is small, consisting of four technical men, a stenographer, two machinists and a janitor. It is therefore not satisfactory to limit one man's activity to any one department. At least two technical men are familiar with any piece of equipment and it is our desire to have all the technical men prepared to perform any test.

In addition to the author, the technical men and their respective universities are: C. E. Sims, assistant research director, University of Illinois, Urbana, Ill.; E. H. Burkart, Massachusetts Institute of Technology, Cambridge, Mass.; G. A. Lilliequist, University of Berne, Switzerland.

Publishes Test Methods for Molding Sand

The American Foundrymen's association, 222 West Adams street, Chicago, now is publishing a revised edition of the test methods issued by the joint committee on molding sand research in 1924. The publication, which is entitled "Standard and Tentatively Adopted Methods of Testing and Grading Foundry Sands," will contain 94 pages and 31 illustrations. The book is divided into five sections as follows: Forward; standards, tentative standards, list of manufacturers of special testing apparatus; and bibliography of articles on molding sand issued since 1922.

Standards given are as follows:

Test for moisture content.

Test for permeability.

Test for strength by compression method.

Test for grain fineness and clay content.

Procedure for making chemical analysis.

Tentative standards are:

Test for green sand strength by transverse method.

Test for green sand strength by tensile method.

Test for green sand strength by shear method.

Test for baked core strength by tensile method.

Test for baked core strength by transverse method.

Test for dye adsorption qualities as indicating bond strength.

Test for sintering qualities as indicating refractoriness.

Grading classification for grain fineness.

Grading classification for clay content.

One copy of this book will be mailed free to members of the American Foundrymen's association upon request, and additional copies may be obtained for $1.00 each. The sale price to nonmembers is $3.00.

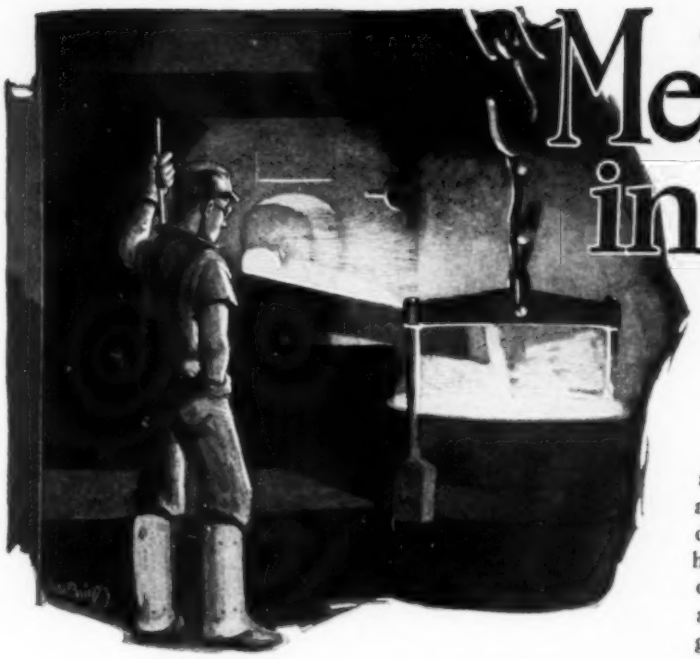
Make Heavy Machinery on Production Basis

(*Concluded from Page* 784)

ing. The next three months are spent in helping on green sand molding. After his three months helping on green sand molding, the apprentice goes to the core making department where he spends a year learning the details of core making. Six months of this period are devoted to small cores and another six months to making large cores. Following the period spent in the coreroom, the apprentice is sent to the pattern making department where he obtains an idea of how patterns are made. Since he spends only 1½ months in this department, he hardly can be expected to become a patternmaker, but he has a working knowledge of this phase of the industry.

Leaving the patternshop, the apprentice goes to the cupola department where, for a month and a half, he learns about cupola operation, mixing and charging metal, and other factors associated with the production of the proper grade of iron for the work in hand. Following this period, he spends three months on bench molding, and six months on molding small work. Nine months are devoted to making medium size castings followed by three months in making large size castings.

To give the apprentice some idea of the various operations performed on the castings in the machine shop, he spends one month in this department, and then goes back to the foundry to round out his course with five months in making molds for large size castings.



Melting Iron in the Cupola

By J.E.Hurst

Part III

OF ALL the various elaborations in design, proposed with the object of improving efficiency and economy of the cupola, the only one retained to any extent is the double row of tuyeres. The modern standard cupola retains the simplicity of its early progenitors in all essential features and relies entirely for improved efficency and economy on the dimensional relationship of its various parts. Arrangement of the cupola units and their subsidiaries; charging arrangements, stock yard, arrangements for storing and distribution of the molten metal contribute largely to the overall efficiency of modern cupola plants. The modern foundry cupola plant layout affords an interesting contrast to the older arrangements, cupolas made from open-sand cast iron plates or old boiler shells, the simplest of charging arrangements and molten metal distribution by horse drawn ladle cars. Full credit always must be given to the unerring instinct of the other generations of foundrymen which enabled them to manipulate more or less primitive cupolas and to produce castings not excelled today. After all, this economical operation is not necessarily the same in all foundries. Widely different character of castings demands different qualities in the molten material. Many factors must be taken into consideration in determining successful and economical melting practice.

Shape and proportions of the internal form of the cupola, number of tuyeres, pressure and volume of the air supply, are among the additional factors, independent of the external features of the cupola shell, which influence successful and economical operation of the cupola.

All these factors to a large extent are under the control of the individual foundryman and his advisors. They offer no serious hindrance to cupola builders in constructing standard ranges of cupolas to take care of various output requirements and embodying their own special forms of construction.

Conditions obtaining in modern foundries demand greater precision and consistency than formerly was the case. They also demand facilities for better and more expeditious manipulation to fit and synchronize with foundry operation constantly developing along lines of greater precision.

Designs Change

ATTENTION is directed to the primitive methods and equipment under which foundrymen of a former generation produced highly satisfactory castings. While these castings, so far as physical characteristics are concerned, compare favorably with any made today, still they were not made at a speed or on a scale to keep pace with advancing requirements of the engineering profession and industry in general.

Table I

Hourly Melting Rate of British and American Cupolas

BRITISH		BRITISH		AMERICAN				AMERICAN			
Shell Diam. Ins.	Rating Tons per Hour	Shell Diam. Ins.	Rating Tons per Hour	Shell Diam. Ins.	Lining Diam. Ins.	Area Sq. Ins.	Rating Tons per Hour	Shell Diam. Ins.	Lining Diam. Ins.	Area Sq. Ins.	Rating Tons per Hour
24	0.5– 1	30	1– 2	28	19	283	0.5	27	18	254	0.25–0.5
30	1– 2	36	2– 3	35	26	530	1– 1.5	32	23	415	0.5– 1
36	2– 3	42	3– 4	42	33	855	2.5– 3.5	36	27	572	1– 2
42	3– 4	48	4– 5	49	37	1075	4– 4.5	41	27	572	1– 2
48	4– 5	54	5– 6	54.5	42	1385	6– 7	41	32	804	3– 5
54	5– 6	60	6– 8	58	46	1662	7– 8	46	32	804	3– 5
60	6– 8	72	8–10	63	51	2042	8–10	51	37	1075	5– 6
72	8–10	84	10–12	67	55	2375	10–12	56	42	1385	6– 7
84	10–12	96	12–15	72	54	2290	10–11	63	45	1590	7– 9
96	12–15			76	58	2642	11–12	66	48	1809	9–10
				80	62	3019	13–14	72	54	2290	10–12
				84	66	3421	15–16	78	60	2827	12–14
				86	68	3631	17–18	84	66	3421	14–18
				91	73	4185	18–20	90	72	4071	18–21
				96	78	4778	22–24	96	78	4778	21–24
				102	84	5541	25–27	102	84	5541	24–27
				108	87	5944	28–30	108	87	5944	27–30

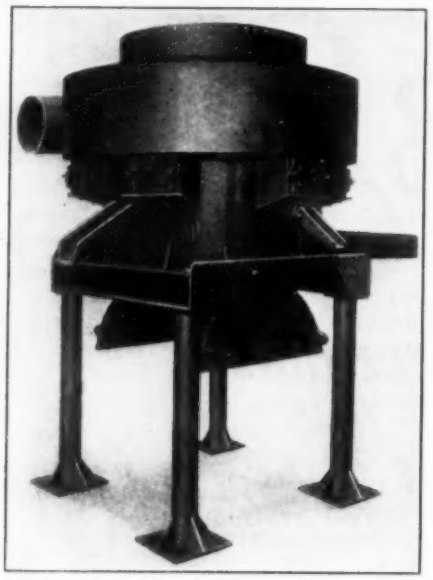


FIG. 11—WHITING CUPOLA DESIGNED FOR LONG HEATS

To meet these conditions, various detailed improvements in design have been introduced into cupolas by the different makers.

Cylindrical construction in riveted mild steel plate is the universally adopted form of modern standard cupola construction. Full detailed capacity ratings and leading overall dimensions of four leading British and American makers are summarized in Tables I and III. These have been selected as typical of the modern range of standard cupolas. Figs. 16 and 18 illustrate the general appearance of cupolas built by the Constructional Engineering Co., Ltd., Birmingham, Eng., and the Whiting Corp., Harvey, Ill., respectively. The other two types referred to in the table are manufactured by the Titgen-Eastwood Co., formerly the J. W. Paxson Co., Philadelphia, and Messrs. New Alldays and Onions Ltd., Birmingham, Eng. Figures given in Table II are typical of continental standard cupola construction.

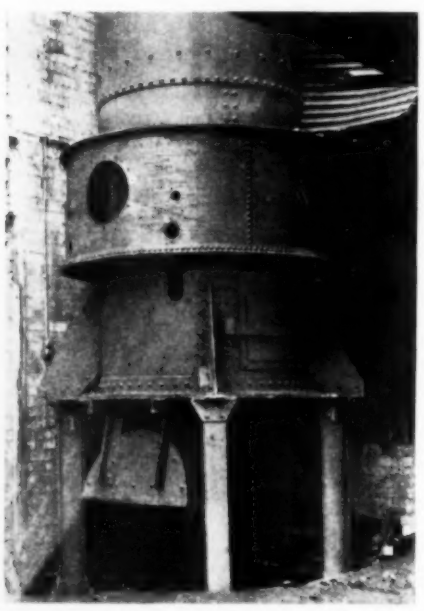


FIG. 12—BRITISH CUPOLA BY PNEULEC CO., LTD.

Comparison of dimensions of British and American cupolas shows little essential difference. The rated capacity of the American large size cupolas generally are larger than the British, while the rated capacity of the smaller British types up to about 48 inches diameter generally are somewhat larger than similar American cupolas.

Cupolas Melt Continuously

The Whiting Corp. also produces a special series of cupolas built for severe long continuous service. Inside diameters and capacity ratings of these cupolas are identical with those of standard series given in Tables I and III. General arrangement of the body section of these special cupolas is illustrated in Figure 11, showing the special tuyere system in this type of cupola. A detailed description of this system is given later under the discussion on tuyere arrangement. Other makers also have special designs for heavy duty continuous service cupolas.

FIG. 13—BOTTOM FEATURES OF PAXSON-COLLIAU CUPOLA

Thickness of mild steel plate in the shell varies according to the diameter of the shell. Broadly speaking, in cupolas of less than 6 feet diameter the plates are ⅜-inch thick. In cupolas above this diameter, ½-inch plates are used. Thick plates are necessary only in the well and melting zone portion of the shell. For the continued portion of the shell up to the charging door and beyond in cupolas of less and greater than 6 feet diameter respectively, ¼-inch and ⅜-inch plates are used by many makers.

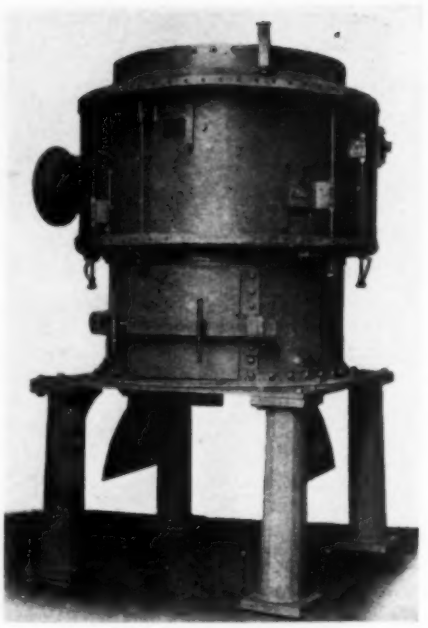


FIG. 14—ENGLISH CUPOLA MADE BY T. DAVIS & SON

Circumferential joints of the plates should be arranged to lap downward to make a weather-proof joint. These joints usually are riveted at 4 to 5 inches pitch, and the vertical seams at 4½ inches pitch. The complete shell commonly is riveted up in two sections to facilitate transport and the two sections are arranged for bolting together during erection on site. The top of the shell usually is provided with a stiffener angle, riveted inside the rim in a manner to prevent excessive percolation of rain between shell and refractory lining.

Suitably placed supports are provided for support of the refractory

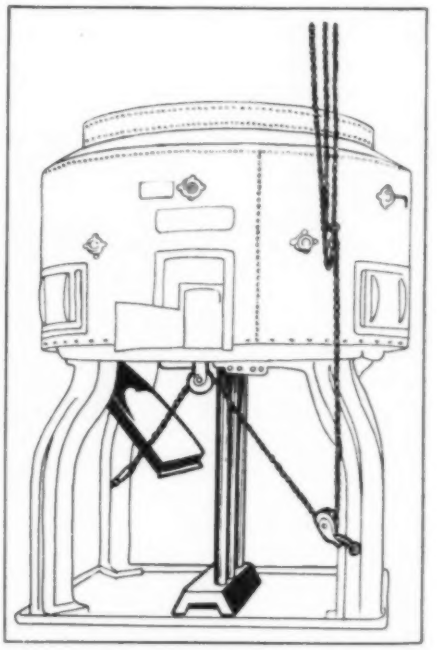


FIG. 15—BOTTOM DOOR HOIST AS APPLIED TO AN AMERICAN CUPOLA

lining. These generally take the form of angle iron rings riveted inside the cupola shell. The first ring is placed from 12 to 18 inches above the air chamber so that the bottom portion of the lining may be renewed without removal of the upper portions. Other rings are provided at suitable levels. To eliminate troubles arising from the expansion of these rings, they should be constructed preferably in segments rather than as continuous rings. In two of the cupolas shown cast iron segments are used for this purpose.

The solid bottom cupola formed by continuing the cylindrical shell down to the floor foundation level, almost entirely has been superseded in modern installations by the drop bottom cupola. Tap hole, slag spout and fettling door are provided at a suitable level and the hearth level is formed by filling the cylindrical shell with firebrick to the tap hole level. The hearth itself is formed in the usual manner of well rammed black sand or ganister. Laborious fettling of solid bottom cupolas will cause any person with a desire to dispute the saving in both personal comfort and

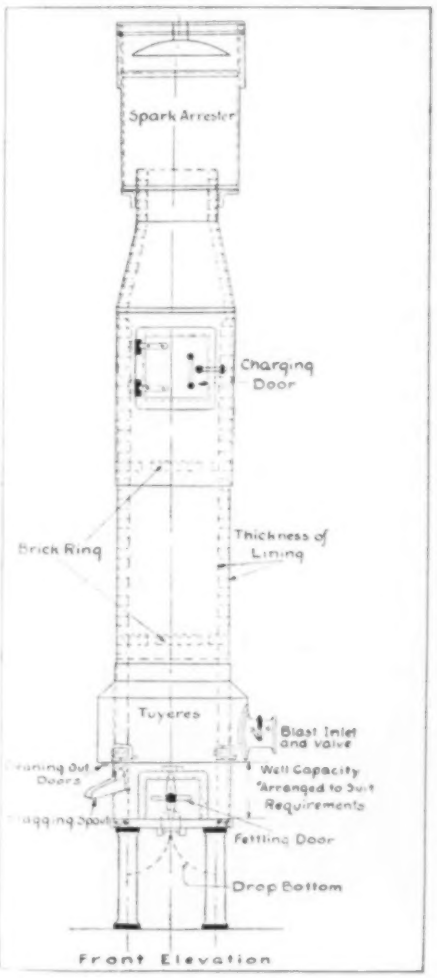


FIG. 16—SECTIONAL VIEW OF CUPOLA MADE BY THE CONSTRUCTIONAL ENGINEERING CO., BIRMINGHAM, ENG.

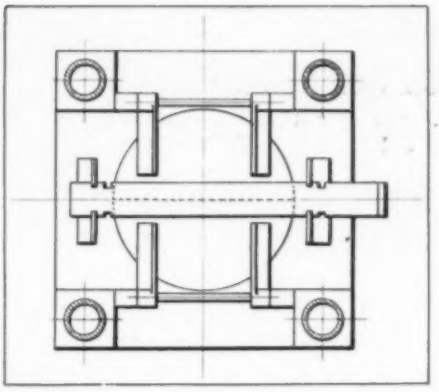


FIG. 17—BOTTOM DOOR LOCKING DEVICE

time of the operators, to revise his opinion when fettling and dumping the cupola at the end of a day's blow under drop bottom conditions. Without doubt the almost universal adoption of drop bottom cupolas is one of the most outstanding improvements in modern cupola practice.

Cylindrical cupola shell is attached to a foundation plate supported on four columns of suitable height. The foundation plate is an important feature in cupola construction and considerable attention has been paid to this by different designs. In all cases the foundation plate is provided with a circular hole not less in diameter than the lined diameter of the cupola. This may be closed by two semicircular doors, hinged to swing somewhat out of the vertical when opened. Remains of the day's charge falls from the cupola when the doors are released.

Need Strong Foundation

Probably the simplest foundation plate construction is a square mild steel plate of heavy section, not less than ⅞-inch thickness for a 36-inch diameter cupola. A well designed and rigid type embodying the use of a mild steel plate, attached to the shell by annular angle iron ring is illustrated in Fig. 12. Added stiffening is obtained by the use of the mild steel buttresses illustrated. In this case the foundation plate is carried on four columns of rolled steel joist with substantial caps.

Rigidity in the Whiting cupola is obtained by a circular cast iron plate construction, carried on T-section cast columns. Similar cast iron foundation plate construction of the Paxson-Colliau cupola is illustrated in Fig. 13. The wind box is independent of the base plate, made in four extra heavy sections and mounted on a steel bearing plate at the joints carried on the columns. The sectional base plate it is claimed, provides for expansion and contraction and therefore will not crack and cause expensive repairs. The Whiting special cupola illustrated in Fig. 11, rests on a foundation plate of heavy structural steel, carried on rolled steel girders, mounted on wrought steel columns filled with concrete.

Opinion probably is divided evenly on the relative merits of steel or cast iron supporting columns and bottom doors. Danger of cast iron cracking under the hot conditions of service is urged against this material, while distortion and subsequent troubles is the chief objection to the use of steel. Experience shows that the danger of cracking cast iron doors is greatly exaggerated. This material is giving good service in thousands of cupolas. Cast iron T-section columns in the Whiting cupola, are splayed to facilitate opening the bottom doors and to permit easy removal of the dropped material. The splayed form removes the columns from contact with the incandescent fuel when the drop bottom doors are open, and in a large measure tends to reduce and eliminate this probable cause of cracking.

Columns usually are erected on a concrete foundation, with the foot of the column bolted through an open sand cast iron foundation plate. Usual-

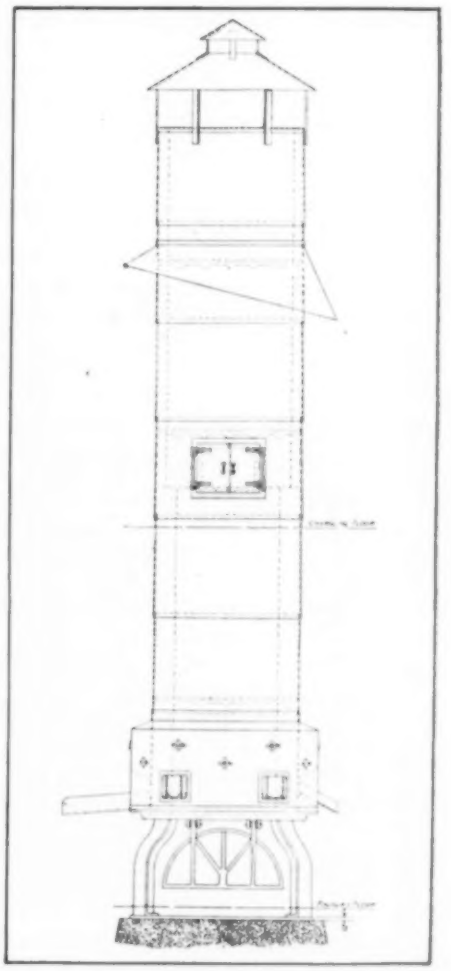


FIG. 18—WHITING CUPOLA EQUIPPED WITH ROOF HOOD AND SPARK ARRESTER

Table II

Dimensions of French Standard Cupolas

Tons per hour	1.96	2.94	3.92	4.80	5.88
Shell diameter, inches	37.4	48.5	56.75	60.7	63.0
Overall height, feet	27.0	29.0	30.0	32.0	36.0
Height of charging platform, feet	14.3	16.0	18.0	19.0	20.0
Thickness of shell, inches	0.236	0.236	0.275	0.275	0.275
Diameter of air inlet, inches	8.75	9.84	11.81	11.81	13.78
Diameter of forehearth, inches	43.0	49.0	55.0	58.0	60.0
Height of forehearth, inches	43.0	43.0	47.0	47.0	49.0
Thickness of forehearth shell, inches	0.236	0.236	0.275	0.275	0.275

ly the columns are tied together by suitable angles or rectangular mild steel bars, to prevent any laterial displacement. In all cases it is advisable to cover the foundation bolts and tie rods with at least 6 inches of earth. Foundation arrangements of the columns are illustrated in Fig. 18. Mild steel rolled joist columns are illustrated in Fig. 12, and a further example of the use of cylindrical cast iron columns is illustrated in Fig. 14. This construction shows the cupola shell and wind belt supported on a square section mild steel foundation plate, bolted to cast iron polygonal section columns.

Illustration Fig. 14, shows a simple form of mild steel bottom door attached to the foundation plate by simple hinges riveted in position. The mild steel bottom door illustrated in Fig. 12, is deserving of special mention. Distortion troubles likely to be encountered in the use of mild steel for this purpose are eliminated by double plate construction. The bottom doors are constructed of two semicircular plates built up by riveted stays, in a manner to form a hollow door effectively maintained cool by normal air circulation. The doors are riveted to angle iron hinges. A neat hinge is formed by a round bar and channel section members, riveted to the foundation plate as illustrated.

Use Cast Iron Doors

Substantial cast iron bottom doors hinged to the foundation plate of the cupola made by the Whiting Corp. are illustrated in Fig. 11. Holes drilled in the bottom doors allow complete venting of the rammed sand hearth. Supporting columns of the cupola must be spaced sufficiently far apart to allow the bottom doors to swing freely. This is specially necessary where cast iron bottom doors are used.

Arrangements for locking the drop bottom doors in position and for easy opening without danger to the operators are of great importance. The simplest form of locking device is a prop and wedge. Usually to facilitate removal of the prop a mild steel link is provided into which a long bar or the crane hook can be inserted to pull the prop away. A suitable snatch block is necessary when using the crane for this purpose. An elaboration of this simple prop illustrated in Fig. 15 is recommended by the Whiting Corp. A special foundation cap is provided with three props and a wedge. One prop is solid and the two outer props terminate in screw tops by which the bottom doors are locked tightly in position.

Method of raising the bottom doors of large cupolas by a chain passing over suitable pulley as illustrated can be operated from a standard air hoist or other suitable lifting arrangement. An ingenious and effective bottom door locking device in use on cupolas up to about 36 inches diameter is illustrated in Fig. 17. A mild steel flat or T-section of sufficient length is provided with four slots at the requisite distance apart. This bar is inserted through T-slotted lugs in the foundation plate diametrically opposite each other along the joint of the semicircular doors. The sliding of this bar along until the slots in the bar enable it to freely fall away from the lugs in the foundation plate, is all that is necessary to free the locking bar and release the bottom doors.

Suffers Damage by Fire

Sunday, Sept. 9, the Walworth Run-Forest City Foundries Co. plant at West Twenty-seventh street, Cleveland, suffered a disastrous fire which damaged the cleaning and pattern storage department. Operations at the main foundry and at the other two plants of the firm were unaffected.

Table III

Principal Dimensions Typical British and American Cupolas

		Total Height Ft.	Height of Charge Door Ft.	Height Columns Ft.	Size of Charge Door Inches	Diam. of Air Belt Ins.	Rows of Tuyeres	Diam. of Air Inlet Ins.
PAXSON-COLLIAU	32	28	11.0	3.0	To Suit Particular Requirements	40	2	
	28	32	12.0	3.0		49	2	
	24	35	13.0	3.0		58	2	
	20	35	14.0	3.5		65	2	
	16	35	14.5	3.5		74	2	
	14	35	14.5	4.0		78	2	
	12	35	15.0	4.0		83	2	
	10	35	15.0	4.0		88	2	
	9	35	15.5	4.5		92	2	
	8	35	15.5	4.5		100	2	
	6	35	16.0	4.5		104	2	
	5	35	16.0	5.0		106	2	
	4	35	16.5	5.0		107	2	
	2	35	16.5	5.0		112	2	
	1½	35	17.0	5.5		116	2	
	1	35	17.0	5.5		123	2	
	0	35	20.0	6.0		132	2	
WHITING	0	To Suit Particular Requirements	As High as Possible with Due Consideration of Size of Heats	....	.....	..	2	.....
	1			2.0	15 x 16 (1)	46	2	6.375
	2			2.0	20 x 20 (2)	50	2	10.00
	2½A			2.5	22 x 22 (1)	57	2	11.75
	2½B			2.5	22 x 22 (1)	57	2	11.75
	3			2.5	24 x 23 (1)	62	2	14.00
	3½			3.0	27 x 29 (1)	67	2	14.00
	4			3.0	27 x 30 (1)	74	2	14.00
	5			3.5	27 x 30 (1)	81	2	17.00
	6			3.5	27 x 30 (2)	84	2	17.00
	7			4.0	27 x 35 (2)	92	2	18.125
	8			4.0	27 x 35 (2)	98	2	18.125
	9			4.5	27 x 35 (2)	104	2	24.875
	9½			4.5	27 x 35 (2)	112	2	24.875
	10			5.0	27 x 35 (2)	118	2	24.875
	11			5.0	27 x 35 (2)	124½	2	24.875
	12			Special	27 x 35 (3)	131	2	30.09
TITAN	2	18.5	13	Particular Requirements	20.5 x 20.5	42	1	7
	3	21	15		20.5 x 20.5	48	1	8
	4	23	16		23 x 23	54	1	10
	5	25.5	18.5		23 x 23	60	1	12
	6	26.6	20		26 x 26	66	1	15
	8	28.6	20.5		26 x 26	72	1	16
	10	33	23		30 x 30	96	1	20
	12	36	24		36 x 36	108	1	24
RAPID	2	22.3	16.5	To Suit Requirements	To Suit Particular Requirements	41	2	7
	3	24	17.5			49	2	10
	4	24.6	18.5			58	2	10
	5	25.8	19.5			68	2	12
	6	26.6	20.5			74	2	12
	8	28.6	22.5			80	2	14
	10	33.0	24			96	2	16

The FOUNDRY Family Photograph Album

Upper Left

THOMAS KAVENY

Herman Pneumatic Machine Co., Pittsburgh

Lower Left

JOHN POLACHEK

General Bronze Corp., Brooklyn, N. Y.

Upper Right

B. H. JOHNSON

Cresson-Morris Co., Philadelphia

Lower Right

F. L. DWYER

Peninsular Stove Co., Detroit

A LEXICON OF TECHNICAL TERMS

By O. W. Potter

(Continued from Data Sheet No. 734)

Microconstituents

Study of the metals and alloys has been aided greatly by a correlated study of the physical, chemical, and micro-properties. The microscope and the X-ray apparatus have been a great aid in determining the causes for certain properties and property changes. It even has been possible in some cases to predict properties of certain alloys before the alloys themselves have been produced.

Microconstituents may be said to be the characteristic appearances as viewed through the microscope of the various constituents of any substance. Most of the constituents of any alloy are easily recognizable through the

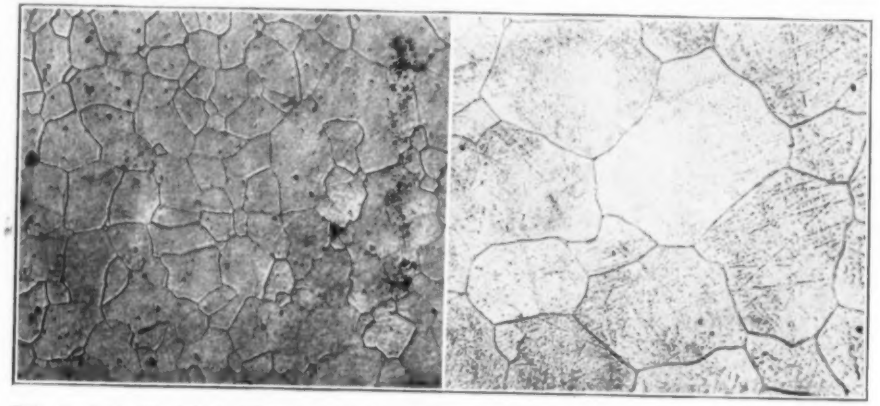


FIG. 5—PURE METAL STRUCTURE—FERRITE—ETCHED, X 100. FIG. 6—SOLID SOLUTION—10 COPPER, 90 NICKEL—ETCHED, X 100

microscope if the specimen is prepared properly. The specimen must be polished carefully and in most cases is etched to bring out the characteristic structure of the constituents. The microconstituents are seldom the actual elements that compose the alloy.

Macrostructure

In metallography the macrostructure is considered as those structural features that can be discerned with the naked eye. A macrograph is a photograph of magnification not to exceed ten times.

Microstructure

Microstructure is considered as those structural features which can only be observed with the aid of the microscope. A micrograph is a photograph of magnification over ten times.

(Continued on Data Sheet No. 736)

A LEXICON OF TECHNICAL TERMS

(Continued from Data Sheet No. 735)

Pure Metal Structure

Characteristic structure of all pure metals viewed through the microscope is considered the pure metal structure. Each metal has its characteristic grain shape, size, and arrangement. These features clearly are shown in Fig. 5, which is a micrograph of ferrite at 100 diameters.

Solid Solution Structure

Solid solution structure is similar to pure metal structure. It is composed of irregular grains, characteristic of the particular solid solution. Other properties must be studied to differentiate between it and the pure metals. *Austenite* is the name of the characteristic solid solution of iron and carbon. It is difficult to obtain this structure in ordinary carbon steels

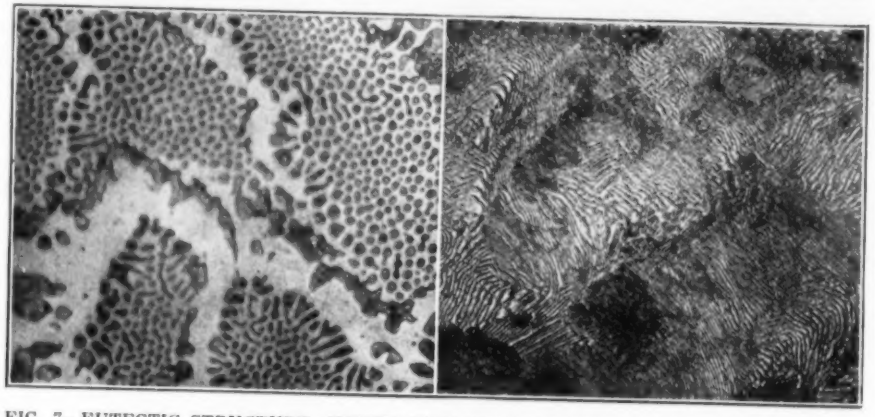


FIG. 7—EUTECTIC STRUCTURE—WHITE CAST IRON—ETCHED, X 500. FIG. 8—EUTECTOID STRUCTURE—PEARLITIC STEEL—ETCHED, X 1000

but in certain alloy steels, such as high nickel and manganese steels, it is quite common. Fig. 6 shows a solid solution of nickel and copper.

Eutectic Structure

Structural appearance as seen through the microscope of the eutectic of any alloy series is called its eutectic structure. In a binary system the eutectic is the alloy of the series which solidifies from the molten condition at a definite temperature (not over a range) forming a solid made up of its two components. For example, in the iron carbon series the alloy with a composition of 4.3 per cent carbon solidifies at a given temperature (about 1130 degrees Cent.) forming austenite (gamma iron) and cementite (Fe_3C). In the case of ternary and quaternary systems,

(Continued on Data Sheet No. 737)

THE FOUNDRY DATA SHEET, OCT. 1, 1928

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Describes Sampling Methods

for Gray Cast Iron

By Raymond H. Hobrock

CHEMISTS long have recognized the difficulty in securing fair samples of gray cast iron because the composition of different portions of the same piece may vary widely and because the subdivision of the portion sampled might introduce large errors in the determination of certain of the constituents.

Many methods have been devised for the reduction of these errors, some of which have accomplished to some extent the purpose for which they were intended and some of which have succeeded only in standardizing the error to such an extent that analysis of different specimens sampled in the same way were comparable. Thus it is possible for a certain laboratory to accomplish control of product and yet operate on a false basis, that is, on values differing from the true values by the constant error introduced in the sampling method.

However, the research worker and those engaged in umpire work are interested in true values and must satisfy themselves and convince others that they have not been guilty of false sampling of the material that their results may be comparable to those of others.

Selection of Sample

The selection of the sample is of primary importance. This does not consist only in deciding upon the use of certain pieces of the material for the sample but consists also in eliminating those pieces that obviously have properties not representative of the whole.

In the case of quite large castings whose chemical composition has been specified definitely, the best practice is to take samples of the molten metal at the beginning, the middle and the end of the pour. The taking of only one sample from the pour is not satisfactory as there is a certain amount of segregation of the metal even in the molten condition. From these selected portions of the pour the sample for analysis is prepared by planing over the entire cleaned surface as is usual in the making of such samples. Segregation in the molten metal is shown by some of the results of tests made by Wust, and presented in *Stahl und Eisen*, 1903, page 1077.

Aside from this regular segregation in the molten metal with its corresponding segregation in the solid metal, many irregularities are found in the cast irons. Thus globules and nodules form in gray iron in the same way that they form in white iron and have a composition much different from the matrix. If by chance such extraordinary formations entered into the sample the results of the analysis would not be representative. Ledebur, *Stahl u. Eisen*, 1900, 582, studied such abnormal formations and their occurrence. He also pointed out that such formations were not uncommon, occurring rather frequently on the surface of castings and varying in size from a flax seed to that of a pea.

Covered With Silica

Groups of crystal and excrescences in cast iron also occasionally are discovered that are much different in composition than the surrounding metal. Ledebur has made observations on such phenomena. Thus a charcoal blast furnace pig showed a large swelling that proved to be a cavity filled with pinetree-like crystals covered with a white coating. Chemical analysis showed that this coating was practically pure silica.

Ledebur also found a mossy-like, whitish growth on the sides of some pigs that were next to the sand. He explained the composition of these formations by assuming that there existed a volatile silicon compound, probably silicon sulphide, in the pig iron. As soon as such a compound came into contact with the air it was oxidized leaving a deposit of silicic acid on the cool walls of the pig or in the cavities.

The formation of bugs (solid leaf-like formations) is rather frequent in hard pig iron and when such abnormalities are discovered the chemist must guard against the inclusion of them in his sample for analysis. Because of these formations that are not representative of the composition of the entire piece it seems desirable that the material immediately in contact with the mold should not be included in the sample, thus avoiding any contamination from the material of the mold (sand) as well as bugs and other formations previously described. However, the segregation of the constituents in the cast piece make it imperative for accurate analysis that portions of the entire section be obtained in proportion to the amount present in the piece.

These conditions are most easily satisfied by planing across the entire section of the piece and preferably at several different sections after a thin cut has been made to remove the skin. Drilling should never be used since in this way the entire section is not covered in the proper proportion and also since abnormalities are likely to pass undiscovered.

If the cut made in the planing process is coarse, the amount of graphite that is freed by the tearing of the tool is smaller than in the case of the fine cut, but the spattering of this graphite dust seems to be somewhat greater than in the case of a fine cut. However, experiments show little (and not consistent) differences made by the depth of the cut if the collection and subsequent preparation of the sample is carried out carefully. Nevertheless, the use of the coarse cut facilitates the initial collection of the sample at the machine and because of this is somewhat preferable.

Maintain Complete Mixture

After the shavings have been collected at the machine on glazed paper they must be prepared in such a fashion that separation of the free graphite from the coarser particles does not occur or this separation must be carried out in a quantitative way. If complete mixture is achieved and easily maintained, the complexity of subsequent weighings greatly may be reduced, but if the material is separated into parts then there must be a separate weighing for each portion removed.

Losano and Cimino, *Giorn. Chim. ind. Applicata*, 4, 521-5, 1922, have experimented extensively on the method of complete mixtures but have not achieved results that recommend this method where great accuracy is desired.

All of the sample from the planer should be ground quite fine (about the size to pass 80-mesh sieve) in a glazed

mortar, with precautions that the amount of fine particles carried away by the air, etc., is small. The sample should be kept in a bottle of such size that the sample does not occupy more than one-half of the volume of the bottle so that it will be possible to mix the sample by rolling the bottle.

If the iron sample is removed from the bottle by the use of the spatula, after such rolling while still in an inclined position, it is found that the results of the analysis for total carbon in such samples will be comparable to the results obtained by the method of Bauer and Deiss which will be described later. This method is subject to the same error that any sample retained in a bottle is subject to, that is, the error occasioned by the absence from the mixture of the small amount of graphite that adheres to the walls of the bottle. However, the method has the advantage over that of Bauer and Deiss in that the probability of loss in screening and transferrings is lessened.

The method of preparing the sample described by Bauer and Deiss is the method widely used for umpire analysis and is recommended for such work by the bureau of standards. This method consists in separating the constituents of the planings into various groups by means of sieves, discovering what amount of the whole each such division is and then either compounding the sample to be analyzed from the proper amounts of each constituent or analyzing each constituent separately and calculating the true analysis from the data. The separation must be carried out in especially designed sieves to reduce the loss of the fine particles to a minimum.

Surrounded by Iron

Examination of gray cast iron under the microscope shows that many of the graphite deposits are surrounded by envelops of iron. If the silicon content is not too low this is normally the structure of the metal resulting from the decomposition of the iron carbide in the process of cooling. If such a material is cut through by a machine tool the little envelop of iron surrounding the graphite particles will be torn open because of their toughness and the graphite will be set free. If, however, such material be crushed by repeated blows then the cracks will follow generally through the most brittle portion of the material, that is, the cementite. If the lines of division be through such material and avoid the tough iron envelops then the amount of graphite set free by the crushing process should be much smaller than the amount set free by any cutting process.

However, in the process of crushing some of the cracks will pass through the graphite areas and some graphite will be set free. The finer the particles produced by crushing the more likely that the graphite would be set free. This appears from a consideration of the limiting conditions. Then it seems that in a mass of the crushed material of hetrogenous sizes the small particles will have lost the most graphite and if the small particles and the free graphite be rejected the remaining large particles might be used for chemical analysis with considerable accuracy. To discover the validity of such reasoning extensive experiments have been carried out on crushed samples with the following results.

Correlates Results

Samples of a piece of gray iron were prepared by planing across the surface and also by crushing in a hardened manganese steel mortar a section that had been cut from the surface. In planing one sample was retained in its original form, that is, in the large chips and the fine powder.

Another section of the sample was ground quite fine in a glazed mortar. The crushed sample was divided into three portions by sieving through calibrated screens with round openings. The results of total carbon determinations made on these samples are as follows:

	Per cent carbon
Planed sample (original form)	3.21
Planed sample (ground fine)	3.17
Crushed samples	.....
Passed 2 mm. retained on 1 mm.	3.04
Passed 1 mm. retained on 0.5 mm.	2.93
Passed 0.5 mm.	2.81

These results appear peculiar at first sight because one would expect the graphite that was lost from the larger samples to be found in the portion that passed the 0.5 millimeter screen. However, this is not the case since this fine portion is made up almost entirely of fine particles of the iron—the free graphite has been lost in the crushing process with the mortar where it passes off as a dust. The results do show that the fine portions lose the most free graphite. As should be expected from the theory, however, it seems that the largest particles used here also lost enough graphite to effect the accuracy of the determination. If the particles are made still larger, the error may be reduced still further, but in this event the particles become so large that a large sample becomes necessary to be certain that it represents the whole of the material. The larger particles are also objectionable because of the length of time required for their solutions in acids; that is, because of the small surface area in relation to the mass.

The variation in the value obtained for the planed sample in the original form and in the fine form is due undoubtedly to the fact that it is difficult to select a good portion from such original planings due to the tendency of the large particles to fall off the spatula and allow the finer particles to remain.

The amount of free carbon in this sample was large. If this be reduced the accuracy of the crushing method is improved, so that in irons containing about one per cent of free carbon, the particles between 2 millimeters and 1 millimeter in size may be regarded as representative.

The bureau of standards has noticed the increase in loss of carbon with the decrease in the size of the particles and for that reason cautions the user of standard samples to mix thoroughly the sample before removing a portion. Thus they found that when a sample of cast iron was milled, mixed and the loose graphite removed by blowing that the carbon content varied with the size of the cuttings in the following typical manner:

	Per cent T. C.
Between 30 and 40 mesh	2.04
Between 20 and 30 mesh	2.27
Between 14 and 20 mesh	2.45

Since the standard samples are composed of that portion which passes a 14-mesh sieve and is retained on the 30-mesh sieve, it easily is seen that careful mixing is always necessary before a portion is removed to overcome the gravitational separation.

Equipment Orders Gain

The index or gross orders for foundry equipment in August was 278.0 as compared with 94.8 in July, according to a recent report of the Foundry Equipment Manufacturers association. The index of shipments in August was 154.1 as compared with 124.8 in July. Unfilled orders gained considerably from 332.1 in July to 467.2 in August. The base is the average monthly shipments for the years 1922-23-24. Comparisons of monthly orders as presented by the association follow:

	1924	1925	1926	1927	1928
Jan.	141.8	104.2	168.2	180.4	132.7
Feb.	121.0	108.8	154.9	198.0	123.6
March	121.9	159.3	157.3	131.1	138.6
April	146.8	124.3	113.2	130.0	107.7
May	108.0	113.3	128.5	134.8	335.6
June	96.4	110.5	133.5	138.4	149.1
July	62.8	117.0	127.3	89.9	94.8
Aug.	77.5	190.0	141.2	106.4	278.0
Sept.	66.0	94.2	114.0	80.4	.....
Oct.	85.5	149.5	140.5	98.0	.....
Nov.	91.4	180.3	133.4	95.8	.....
Dec.	137.8	140.1	181.0	106.8	.....

Conserve Man Power by Eliminating Steps

By Edwin Bremer

IN THE first part of this series which appeared in the Sept. 15 issue of THE FOUNDRY, a brief description of the plate foundry was presented. From that brief outline the reader has obtained a general idea of the large amount of equipment installed and how it operates. In this article a more detailed description will be presented to show how this installation not only has relieved the drudgery of labor, but also has led to greater production of a quality product.

As has been mentioned previously, two distinct systems of mold handling are in use in the plate foundry. In all, there are four different units, two of which employ gravity roller conveyor units, and two which employ the sliding plate system. The largest unit which will be described first is placed along the north wall of the foundry. It is rectangular in shape and is about 40 x 100 feet. Molding machines are placed near the wall of the building, and the gravity conveyors arranged perpendicularly to the walls extend to the wide gangway through the center of the shop.

A long apron conveyor placed about a foot below the floor level extends the whole length of the molding unit just at the edge of the gangway. The roller conveyors extend over the apron conveyor, and the sand and castings are shaken out upon the apron conveyor which transports them to the upper end of the system. Here the sand and castings drop on a jar screen which jolts the sand from the castings. The sand passes through the screen to the sand handling system, and the castings go to a cross conveyor. Castings from this conveyor are cleaned in a rotary sandblast table at the end of the conveyor, or are taken from the conveyor and sent to tumbling mills a short distance away.

Fig. 10 shows the head or molding machine end of one of the units. As may be surmised, the molding machines are arranged in pairs side by side. One of the machines is used for making the drags and the other for the copes. Behind each pair of machines a gravity roller conveyor which extends from the previously mentioned apron conveyor, carries the

Fig. 9—In Drag Plate Molding No Flask Is Used for the Drag. The Drag Is Shown at the Right and Closing the Mold at the Left

Fig. 10—Machines Operated in Pairs Are Close to the Roller Conveyors, Eliminating Unnecessary Steps

empty flasks. On the other side of the two machines, another roller conveyor transports the finished molds toward the apron conveyor. The molding machines used for making drags in this unit are jolt rollover machines, and to facilitate handling the molds, the draw platen which receives the mold after it is rolled over, is equipped with rollers. The rollers enable the molder to push the mold toward the conveyor instead of carrying it from the machine. This feature easily may be seen in Fig. 9. Copes are molded on strip machines.

Shake Out Castings

Fig. 15 shows the lower or pouring and dumping end of one of the units. This view also shows the apron conveyor at the edge of the gangway. The molds are poured as shown in Fig. 15, and when the iron is solidified but still red hot, the flask is shaken out. The sand and castings drop upon the apron conveyor, and the flask is placed on an adjoining roller conveyor which carries it back to the molding station. Small flasks are shaken out by hand, but in the case of the heavier ones, this work is performed by vibrators mounted on a yoke as shown to the left of the man pouring. These vibrators are attached to pneumatic hoists made by the Curtis Pneumatic Machinery Co., St. Louis, which in turn are suspended from monorails.

Small bull ladles which will hold about 500 pounds of molten metal carry and pour this section of molds. As shown in Fig. 15, these ladles also are attached to pneumatic hoists similar to the vibrators. Molten iron for the small bull ladles is brought from the cupola in larger ladles having a capacity of about 1600 pounds. The large ladles are transported by an electric, cab-type crane, manufactured by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. This crane travels on a monorail supplied by the Louden Machinery Co., Fairfield, Iowa.

After the castings and sand are dumped on the long apron conveyor, they are transported to the upper end of the system as previously mentioned. Just before reaching the end, the apron conveyor is elevated about 8 feet above the main level by a short incline which may be seen in the left background of Fig. 15. A view of this incline from the opposite end is shown in Fig. 12. The sand and castings travel up the incline and are dropped a short distance to a jar screen mounted at a slight angle. The jolting of the screen not only shakes the sand from the castings, but also causes the castings to move toward the cross conveyor at the end of the screen. This cross conveyor is just in front of the men shown in Fig. 12.

Knock Off Gates

As the castings slowly move along the cross conveyor, the gates are knocked off and thrown into boxes placed on skids similar to those shown in the illustration. Also, any defective castings are removed and thrown into boxes. The cross conveyor leads to a rotary sandblast table manufactured by the Pangborn Corp., Hagerstown, Md. However, not all castings are cleaned by this method. As they pass along the conveyor, some of them are placed in boxes and sent to a battery of tumbling mills placed across the upper end of the shop. Some of these mills are shown in Fig. 13.

The battery contains 7 large tumbling mills which were supplied by the Whiting Corp., Harvey, Ill. After cleaning, the castings are taken to a battery of stand grinders arranged behind the tumbling mills where such irregularities as those where the gates

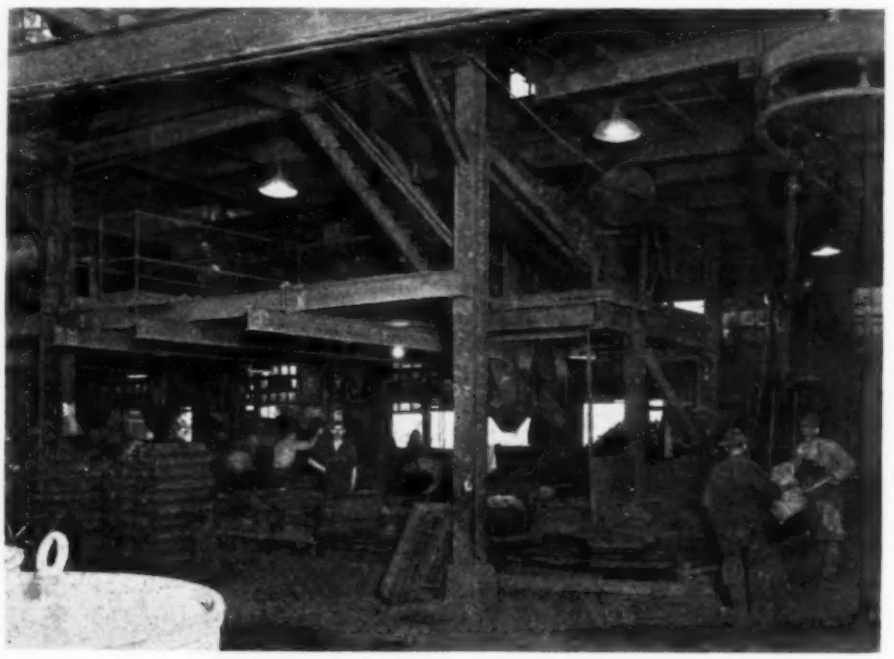


Fig. 11—Molders in the Center Forward the Finished Molds to the Conveyor Chain Around the Outside. Pouring Is Done at One End

were attached, are ground off smooth.

Sand from the castings and flasks drops through the circular openings in the jar screen into a hopper that forms the boot of a bucket elevator which is erected at a slight incline from the vertical. This elevator may be seen at the left of the end of the apron conveyor incline shown in Fig. 12. Sand from this elevator is dumped into a storage hopper having a capacity of about 8 tons. This hopper is shown at the left of the elevator just mentioned. Before the sand goes into the hopper it passes over a vibrating screen which breaks up any lumps and removes any large pieces of tramp iron, etc. From the hopper, the sand is spread in a thin layer on an inclined belt which carries it to the aerating unit. As the sand passes along this belt a man, stationed at the side of the hopper, adjusts a water spray so that the proper amount of water for retempering is added.

Just before the sand passes into the aerating unit it goes under a short belt passing over a magnetic pulley which removes any small pieces of iron such as shot, etc., which was not removed at the vibrating screen. After the sand goes through the aerating unit, it drops on a long conveyor belt which extends the whole length of the molding unit directly over the molding machines. Deflectors arranged over a storage hopper at each machine are adjusted by an attendant so that each hopper is kept full. Any excess sand is carried across the unit on a belt and dropped down upon the apron conveyor at the other side. Equipment such as the apron conveyors, jar screen shakeout, and the sandhandling system used on the unit just described, were supplied by the Link-Belt Co., Chicago.

Fig. 13—A Bank of Seven Tumbling Mills Is Used for Cleaning Part of the Castings Produced. Others Are Cleaned by Sandblasting

Travels on Conveyors

Adjoining the unit previously described at the end, is another type of mold handling system shown in Fig. 11. In many respects this system is similar to the other one. Gravity roller conveyors manufactured by the Mathews Conveyor Co. carry the molds from the machines, and return the empty flasks to the machines. However, instead of the molds being poured at the ends of the conveyors, they are placed on a chain conveyor system which travels around the outside of the unit. This conveyor chain system was supplied by the Link-Belt Co., Chicago. This unit is about 40 x 70 feet.

A view of the head or molding end of this system is shown in Fig. 9. Another feature of this unit is the method of molding which is known as drag plate molding. This unit employs 6 pairs of molding machines manufactured by the Milwaukee Foundry Equipment Co., Milwaukee. As in the other system, a roller conveyor behind the machines which are side by side supplies the plates for the drag machine and the flasks for the cope machine. A roller conveyor situated on the other side of the machines carries away the molds.

Fig. 12—Castings from the Apron Conveyor Drop upon a Shaking Screen that Removes Most of the Molding Sand

Use One Flask

In making the drag half of the mold, no flask is used as may be seen in Fig. 9, which shows two of the steps in making the mold. At the right of this illustration is shown a completed drag which is made on a plate supplied by the Wadsworth Core Machine & Equipment Co., Akron, O. A layer of sand about two inches deep with the sides sloping in at approximately 30 degrees forms the joint with an opposite replica in the cope which is made in a flask supplied by the Sterling Wheelbarrow Co., Milwaukee. The flask rests directly on the bottom plate mentioned.

This unit also employs rollers on the draw platen of the jolt rollover machines. When the molder makes a drag he pushes it on the conveyor opposite the cope machine where, as in Fig. 9 the cope is lifted from the molding machine, and the mold closed. As mentioned the molds are pushed down the gravity conveyors to the chain conveyor which travels around the outside of the unit, and is shown in Fig. 11.

The chain conveyor consists of a chain attached to plates which slide on rails. The plates contain a short section of rollers and as it passes the conveyors containing the molds, a mold is pushed on each plate by an attendant. The molds then travel to lower end of the system where they are poured along the short side as shown in Fig. 11. After the molds are poured they travel up the other side and back across the opposite short end. When they reach this point, the molds are dumped on a jar screen. The sand passes through the openings in the screen to a belt and then through a sand handling system where it is tempered and aerated, and sent by a conveyor belt to the storage hoppers above the molding machines. Castings from the jar screen drop on the end of the apron conveyor which was mentioned previously, and are carried up to the other end of the shop.

Opposite this molding unit and across the gangway from it, is a third unit which employs a similar type of conveyor chain and sliding plate to handle the molds. This apparatus also was supplied by the Link-Belt Co., Chicago. The unit is about 20 x 70 feet. Twelve squeezer type molding machines manufactured by the Tabor Mfg. Co., Philadelphia, are placed inside the unit along one long side. The molds are placed on the sliding plates as they pass the machines and are poured along the short end at the lower portion of the unit.

After pouring, the molds are moved up the other long side and across the upper end of the mold handling unit. Over near the opposite long side the molds are dumped out by hand onto a jar screen as shown in Fig. 14. As may be seen in this illustration, one man dumps out the molds and places the empty flasks on a roller conveyor which carries them along the sides of the molding machines. The castings on the shakeout screen slide to the lower end where another man picks them up with a pitchfork and throws them into buckets or boxes mounted on skids. When the boxes are filled they are carried to the cleaning department at the upper end of the foundry.

Sand from this unit is handled in a similar fashion as has been described. Conveyors carry the sand to the tempering and aerating units and then to the storage hoppers above each molding machine.

The fourth molding unit is separated from the third unit by a narrow gangway. It is parallel to the third unit previously described and in many respects is similar. The main difference between the two is that the fourth unit is much narrower across, being about 10 feet wide, and the molding machines instead of being placed inside the unit, are outside. The principle employed in this unit is the same as the other, that is, a conveyor chain attached to plates with hard iron shoes which slide on light rail sections, is used to convey the molds.

The molds are shaken out in the same fasion as on the third unit. The flasks, after being emptied, are placed on the conveyor which carries them to the machines. Sand and castings are handled in the same manner as described in the other unit. Twelve molding machines are employed on this unit and all are squeezer type machines supplied by the Tabor Mfg. Co., Philadelphia.

Metal for the castings made in the plate shop is melted in one of a pair of cupolas which are used alternately. The cupolas were made by the Whiting Corp., Harvey, Ill., and will melt from 125 to 150 tons in a 9-hour shift. The cupolas are placed at the lower end of the foundry, and the molten metal is carried to the pouring stations in 1600-pound ladles. The ladles are transported to and fro by an electric cab-type crane supplied by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., which operates on a monorail supplied by the Louden Machinery Co., Fairfield, Iowa.

The crane not only carries the molten iron to the pouring stations, but also it is used for transporting buckets containing scrap and sprues

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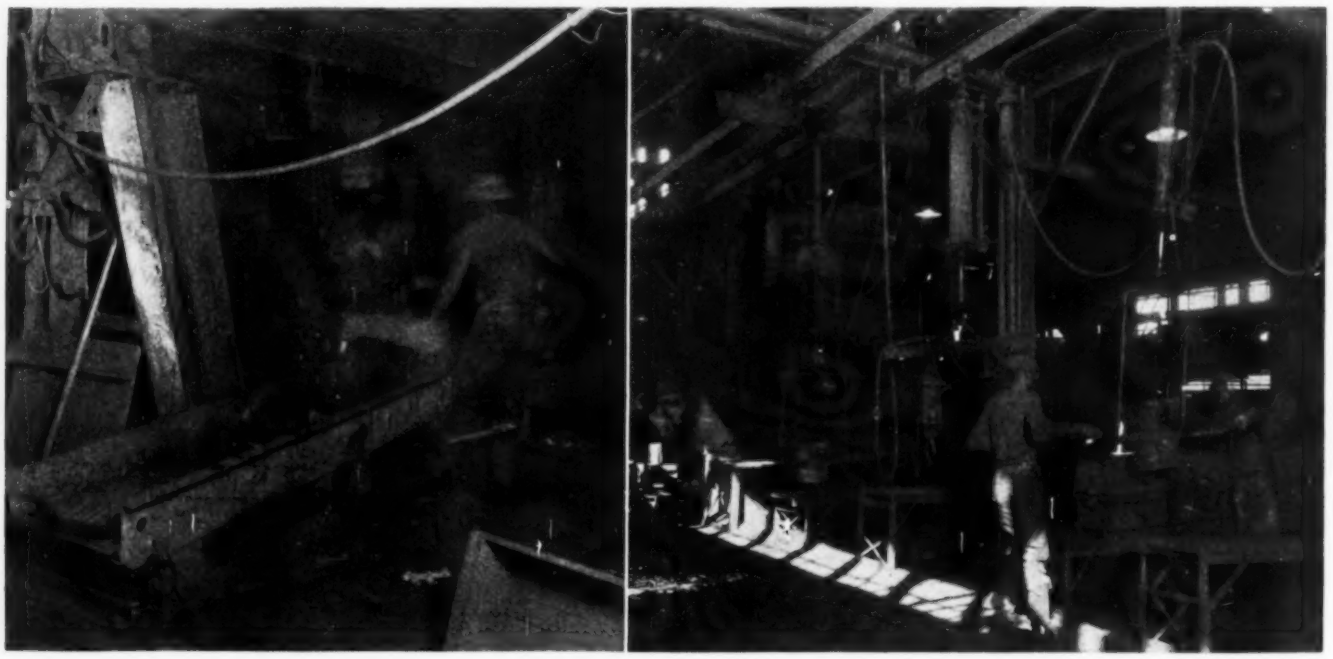
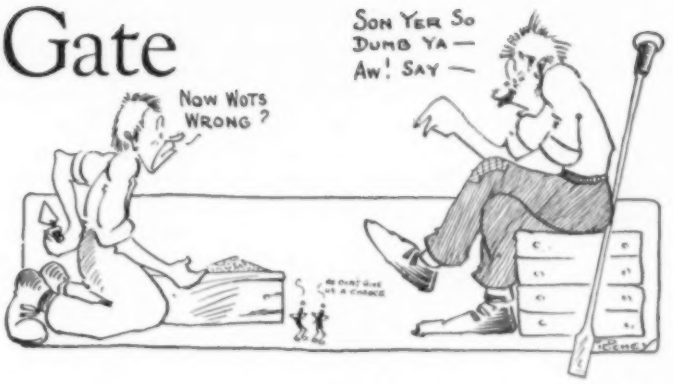


Fig. 14—*One Man Shakes Out the Castings from One of the Units. The Rapid Pulsations of the Screen Remove the Sand. Fig.* 15—*Castings Are Poured at the Ends of the Conveyors. They Are Shaken Out and Drop to the Apron Conveyor Below*

Bill Tells How To Gate a Pan Casting



By Pat Dwyer

HAVE you ever stopped to consider how an apparently trivial remark remains in your mind for years and years and exerts an influence on your opinion? Without waiting for the whole-hearted and enthusiastic reply in the affirmative which I know is forthcoming, unless you are a confirmed crab ready and willing to start an endless argument over every statement you hear or read, I will mention one, just one out of a list in my own experience to prove this little point.

You may say, "Well, what of it?" or, "Who cares?" or any other witty remark which springs spontaneously to mind under similar circumstances.

That is all right with me. You are not present to don the gloves and by the time this appears in print I will have forgotten all about it. Therefore, you are warned in advance that any attempt to take up the argument by correspondence will just represent so much wasted time and effort. If I get an indignant letter some time in the future telling me in chaste foundry language that I am full of baloney I will throw it away with a fine nonchalant gesture and write back "So's your old man," or, "Well, what of it?" How will you like that, hey?

However, far be it from me to inject the controversial element. Essentially, I am a man of peace and will do anything, within reason, to keep out of entangling alliances of any kind. Naturally if I am backed into a corner I will endeaver to put up as vigorous a defense as possible; but that is a long way from saying that I go around truculently balancing a chip on one shoulder. Talking about chips reminds me of a fellow, a remarkably low fellow—Oh, well, let it go this time, I may return to it later. If I started talking about this lad, I might wander away from the original subject. If there is one thing more than another which arouses my ire and makes me wish for unlimited power of life and death, it is the reprehensible and all too common habit of some people to start talking on one subject and then wander from the path into an impenetrable maze where they become hopelessly lost.

When I set my feet on a conversational path I like to follow it to a definite conclusion. I was tempted strongly in the preceding paragraph to step aside just for a moment to direct your attention to the word *ire*. So far as my memory extends I never have heard any person use this word in ordinary conversation. For a positive fact I know I never have used it in my comparatively limited conversational contacts with my fellows and yet I am so familiar with the word in printed form that I set it down spontaneously and unconsciously. I give you my word I was surprised just now to see it staring back at me from this page.

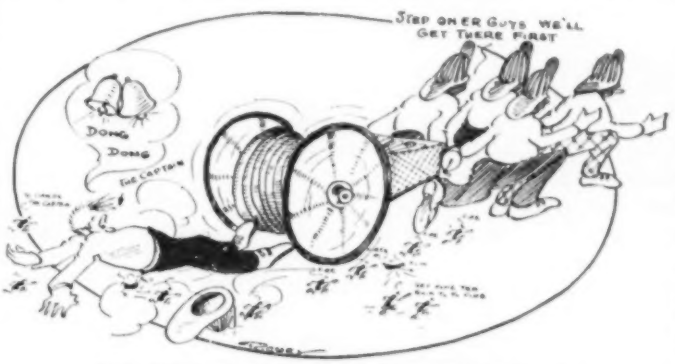
Fortunately the iron discipline I invariably practice while writing, prevented me from commenting on it at the time and I merely mention the incident now to show how easily a person may wander from a theme unless, as I do, he constantly keeps his eye and mind on the goal.

As I was saying before you interrupted me, a trivial incident in the early and formative years may affect your entire outlook on life. I intended to quote one incident out of my own experience to prove this point and would have done so long since if I had been given the opportunity. A man cannot pursue a straight and narrow path if he is pushed and jostled at every step.

Up to the time I entered the foundry I had been more or less familiar with the saying, "Everything comes to him who waits." In my innocence and ignorance I quoted this saying one day to an old pagan molder who had sent me for a drop of feeding iron. Although he had no religious affiliation, he had a more bulging vocabulary than the director of a theological seminary and he used it prodigally for the benefit of lazy young skylarking apprentices who did not have sense enough to know that when a man wants feeding iron, he wants it the same day he sends for it.

"Everything comes to him who waits, hey?" he concluded sneeringly. "Lemme tell ye something, young-feller-me-lad, you'd stood a (deleted by censor) long time on Bell's corner waiting for a man to drive up with a barrel of flour unless you had the price."

At that period of my existence I was not doing any worrying over barrels of flour. We always had one in a kind of a pantry, cunningly constructed under a crooked stairway, but how it came there, or how a filled barrel replaced an empty one, gave me no more concern than the meals I ate. I accepted both as naturally as the air I breathed and wasted no time speculating on their origin. Youth is a blessed period of existence. The idle remark of the hairy old pagan set me to thinking and among other things it caused me to check up on certain items in which I was interested. As nearly as I can figure out after many years' experience, the old saying "All things come to a man who waits," is partly right, but mostly wrong. The majority of things for which we wait, never arrive. Sometimes when they ar-



THE RACE IS NOT ALWAYS TO THE SWIFT

rive, the wait has been so long, we don't want them. Occasionally they arrive before patience finally is exhausted and then the old faith revives. We resurrect the old bromide and remark brightly to all and sundry that all things come to the man who waits.

For several years I have toiled and moiled, as the saying goes, in a building separated by a single block from a fire station. Between ourselves I have no idea what *moiled* means. However, for some—to me—unknown reason the two words always go together and I use them in preference to the more prosaic statement that I work in this place. Work is a rather elastic term and may mean much or little, but when I say that I toil and moil, you get the proper impression of a galley slave chained to the oar, the poor but honest working man carrying an insupportable load, blinded with sweat and so forth and with the nails worn down to the quick on the old gnarled hands. The fellow who invented the term toiling and moiling said a mouthful. During all this toiling and moiling period I have been buoyed up by the hope that some day I should see a fire. It has been a simple and innocent wish on my part, one well within the scope of the saying that all things come to the man who waits. What has been the result? That aggravating fire department, horse, foot and artillery has dashed out of its den on an average half a dozen times each day to fight some silly fire altogether beyond my range of vision. Do you think that's nice?

Each time I hear the clanging bell and the wailing siren warning traffic to stand clear, I glance hopefully and expectantly over the edge of my little nest in the old ivy tree. Surely, I say to myself, *this* time these birds will park in our vicinity and give me a chance to see them in action. "Hope long deferred," sayeth the psalmist, "maketh the heart sick," or, according to the modern version, it gives one a pain in the neck.

Yesterday the miracle happened. The old faith came gushing back, pure, limpid and strong as the stream from the rock that was struck by Aaron's rod. Once more I am back in the fold, a firm believer in the sterling old classic "All things come to the man who waits."

True, the fire did not amount to much, but it was a genuine, bona fide fire and I had an unrestricted view of it from the moment the first clouds of smoke rolled out of the windows until the firemen rolled up their hose and departed for their headquarters. The crowd of idlers and others who needlessly dropped their work, interfered with my view at times in the most annoying manner, but I was glad to see that the firemen have lost none of their old time vigor and technique. They smashed all the windows in the front of the building,

VANISHED FIRES OF YESTERDAY—IN TWO REELS

presumably to allow the smoke to escape more readily. Then they pounded large, gaping holes through the iron and glass sidewalk skylights and flooded the basement.

I mentioned this point to Bill last night. He waved it aside with the careless remark that I hadn't seen nothin'.

"These here modern firemen," he said, "are pretty good and do a fair job at times, but they ain't a patch on the old volunteer fire laddies who toiled on a long rope and dragged their apparatus on the dead jump over mud puddles and cobblestones of the old home town. These lads did not work for pay, for a meager portion of the old filthy lucre. Not they. They worked—believe me they *worked*—for pure love of the game and for the excitement incident thereto. All the excitement and fun was not confined to extinguishing the fire. Usually that was only a side issue and the least of their troubles. Most of the fun lay in beating—and when I say beating, I mean beating and nothing else but—some other gang in the race.

"Once the race started, nothing could stop 'em. I'll never forget one night and I guess Tommy McInnis never will forget it either, although probably for a different reason. Tommy was captain, one of these pompous little turkey-cock kind of fellows, who would prefer death by slow torture to being placed in a ridiculous position.

"About 50 yards from the fire station, Tommy in his lead position on the rope, stumbled and fell and the entire gang of 12 big husky brutes raced over him with their hobnailed shoes. To finish the job properly they pulled the heavy hose cart over him despite his agonized yelps of protest and profane orders to stop the procession. He might just as well have tried to stop the falls of Niagara, after which the doughty company was named. All kinds of records constantly were broken in grabbing the apparatus and rushing to the scene of the conflagration. Every fire was a conflagration in those days, irrespective of whether it involved a complete block or only the soot burning in an old tumble down chimney. Arrived at the scene of action, the fire usually was ignored while the firemen staged a pitched battle to decide which gang should couple on to the fire plug. The defeated gladiators then attacked the doors and windows with large shining axes, while the lads with the hose drenched them with water and valiantly tried to drown them or at least knock them off their feet.

"The toughest bird in the bunch, armed with a long spanner, stood guard over the fire plug and waged a constant warfare with scurvy knaves from other companies who wanted to attach their own hose. He was not particular where he hit 'em, on the knuckles, on the shins, above and below the belt and once in a while he bounced a shrewd one on a hard head that rung like a Chinese gong.

"When the opposition became too strong, the defender shouted lustily for help and his gang promptly dropped the hose and allowed the fire to take care of itself while they reestablished their prestige as the first on the scene and therefore the logical protectors of life and property.

"A high sense of duty led those boys to treat a false alarm as seriously as a real fire. They dashed up to the premises after the manner of Attila the scourge of God, hacking his way through a captured town. While one gang adjusted the hose and smashed all the windows, the others gallantly wielded the axes and

reduced the front door to kindling wood. Honest householders danced from one foot to the other, frothed at the mouth and indignantly denied the presence of any fire. Helpless women and children with tears dribbling from their eyes, got down on their bended knees and begged the Goths and vandals to desist, but the boys, in strict conformity to their bounden duty insisted in dragging hose up and down stairs and thoroughly wrecking the place before admitting that no fire existed. Usually they insisted on ripping all the shingles from the roof and giving it a thorough wetting as a preventive measure before retiring.

"Those good old rollicking, riproaring days have gone forever. The hairy chested fireman with his red shirt, his tin helmet and his spiked axe has been relegated to the limbo of forgotten things with free silver, free beer, the cross of gold and the bicycle built for two. Modern fire fighting has been raised to the dignity of a profession with nattily dressed operators working under a discipline as rigid and as efficient as that prevailing on a battleship.

"Everything changes. Introduction of molding machines in the foundry has necessitated certain changes in dealing with specific patterns. The other day I had a letter from a man who was puzzled over the gating of a casting.

"He wrote: 'We are forwarding a blueprint of a casting which is causing us considerable trouble through dirt and cold shuts. You will note it is a rectangular pan shape casting 55 inches in length, 23 inches wide, 11 inches deep, with an average metal thickness of 5/16-inches and with a flange surrounding the top on the outside. Various openings, pads and bosses are attached to the outside surface, on the sides and on the bottom. The casting is machined quite extensively and in addition must withstand steam and water pressure. The pattern is mounted on a board and the mold is rammed on a roll-over jolt machine. We are wondering if our gating system is at fault and will appreciate your advice on how to gate the casting to the best advantage.'

"Here's a carbon copy of my reply: 'Since you do not show or describe your present method of gating the casting I cannot venture an opinion regarding its suitability. However, I am inclined to the opinion that the condition of the mold and not the gating system is responsible for the defective castings. The shape, size, area and position of the gates exert a considerable influence on the condition of the resulting casting, but if every other factor is favorable, the style of gating may be varied to a considerable extent without adversely affecting the casting. For example consider bathtub castings made successfully in immense quantities. In some plants these castings are poured through a set of pop gates of either the *wedge* or *finger* type located on the bottom of the tub which in the casting position is the highest point in the mold. In other plants the casting is poured through two runners on opposite sides of the flask, each runner connected to a long channel paralleling the edge of the tub at the joint between cope and drag. Iron from these long channels enters the mold through short, flat shallow branches spaced about 2 inches apart the entire length of the casting.

THE WISE DOCTOR DODGES HIS OWN PILLS

" 'Your casting although not so deep, resembles a bathtub in its general features and I assume you are molding it in the position universally adopted by the manufacturers of these castings, that is flange side down. For several reasons, but principally on account of the machined areas on that part of the casting corresponding to the bottom of a bathtub, I suggest you adopt the second style of gate to which I referred.

" 'Two features are essential to the success of your casting. One is hot iron and the other is a sand that can be rammed fairly hard without causing the iron to *kick* away from it. If you were ramming the sand by hand you could use a *closer* sand than where the sand is rammed on a jolt machine. For example the sand forming the inside of the mold would be packed firm but not hard, by tramping it down. The sand around the joint would be rammed much harder. Similarly the sand around the lower edge of the cope would be rammed hard to prevent a strain or a run-out, but higher up and on top the sand would only be rammed hard enough to hold it in the cope. This condition practically is reversed in ramming the drag on this particular casting. The mound of sand forming the inside of the casting occupies the lowest point near the table of the jolt machine and consequently is rammed the hardest.

" 'Two precautionary measures are required. The first is to use an open grade of sand. The second is to jolt the drag just sufficiently to pack the sand inside the pattern to the desired degree of density. The remainder of the sand in the drag, particularly along the joint should be butt-rammed. Also it may be advisable to use a vent wire on the drag. Other contributory causes may be responsible to some extent for your trouble, but the presence of dirt and cold shuts indicates commotion while the iron is filling the mold. By preparing a mold which the iron will fill quietly, you need not worry unduly about the style of the gates. The only really essential feature of the gates is a set that will fill the mold rapidly without imposing too severe a strain at any one point.'

"Talking about reading and writing and all that kind of stuff," Bill remarked, "reminds me of the old gentleman who saw a small boy with a bundle of papers under his arm. After the fashion of nosey old gentlemen he said, 'don't all these papers make you tired, my boy?'

" 'Naw,' says the kid, 'I don't read 'em!' "

Recommends Established Cost Systems

The board of directors of the American Foundrymen's association, 222 Adams street, Chicago, recommends to all steel foundries the cost system adopted by the Steel Founders' Society of America and to all malleable foundries the cost system adopted by the Malleable Iron Research institute. The board also recommends that the Gray Iron institute be encouraged to develop a cost system for gray iron foundries. The members of the association are being circularized for suggestions and comments on a cost system for nonferrous foundries and for members of a nonferrous sub-committee of the A.F.A. committee on costs. In 1926 the A.F.A. cost committee formulated standard cost divisions for foundry cost accounting systems which are applicable to all branches of the foundry industry.

Minimizing Disintegration of Refractories Due To Spalling

By Stuart M. Phelps

TWO major causes, in general, account for the destruction of refractories in furnaces. These conditions which are so common are more serious than all the other destructive forces combined. If spalling and slag action were not encountered, problems with refractories would be comparatively simple. Furthermore, they are most difficult to combat by reason of their obscure and complicated manner of occurrence. Their presence is always apparent, but the analysis and detailed explanation of how they proceed and how to prevent their action require careful consideration. Studies conducted in recent years on these subjects have been most valuable. They have simplified problems materially, especially by way of offering explanations as to the operation of spalling action. To be sure, the description of "how" and "why" is not as important as "how to prevent," but the cause must be known before a cure can be applied intelligently.

Spalling action has been defined by the American Society for Testing Materials as the "breaking or cracking of refractories to such an extent that fragments are separated, presenting newly exposed surfaces of the residual mass." Included with this definition is a listing of the three subdivisions of spalling action—thermal spalling, mechanical spalling and structural spalling. The accompanying chart lists these three types with the factors related with respect to service and to refractories. Such a division of this subject is desirable from both the practical and theoretical viewpoints. The corrective measure for one type of spalling may not be suitable for the others. Often times the cure may be furnace design or operation, while in another type the answer is a more suitable grade of brick. From the experimental angle the division simplifies a difficult problem. A fundamental requisite of all research is to divide the major problem into its constituent parts and to concentrate on each of these. Subsequently, the answers to each small problem may be assembled to solve the original problem which first engaged attention.

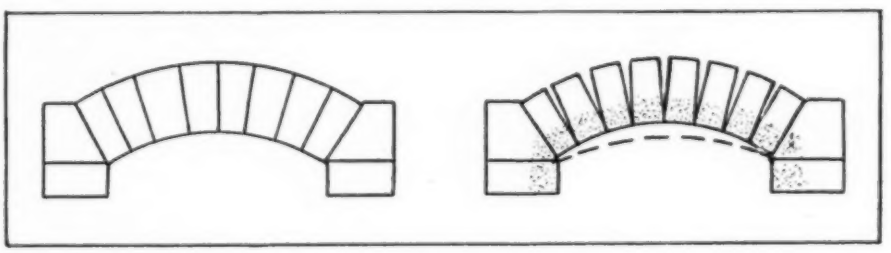


Fig. 1—Refractory brick arch before and after heating. Shaded portion indicates presence of heat. The dotted line indicates the original position of the arch

The most simple division in the three is that of mechanical spalling. Under this heading are included the purely mechanical questions which will be noted. In most instances they can be overcome or corrected with due attention to furnace design and operation. For example, brick are often set in a wet condition and require considerable time to be thoroughly dried. If they are heated too rapidly while wet there is real danger in the formation of steam under pressure within the pores which will expand and weaken or crack the brick. In some furnace operations there are areas of the brickwork upon which slag and clinker build up. This is often removed by laborers using a heavy, unwieldy bar. It is a difficult job at best so that it often happens that considerable brickwork is unnecessarily removed. The only remedy for such a loss, after it is minimized by careful operation, is to use the strongest brick possible consistent with other properties that are required. A common cause of mechanical spalling is that called "pinching." The pinching is caused by the pressure exerted when the bricks expand during heating. Refractories, like other materials, ex-

From bulletin 24 of the American Refractories Institute, "A Nontechnical Description of Spalling Action." The author, Stuart M. Phelps, is director of research and tests of the institute.

Related Factors of Furnace Refractory Spalling

MECHANICAL SPALLING FACTORS RELATED		STRUCTURAL SPALLING FACTORS RELATED		THERMAL SPALLING FACTORS RELATED	
To Service	**To Refractories**	**To Service**	**To Refractories**	**To Service**	**To Refractories**
Rapid heating of wet brick; abuse in removing clinker and slag; unequal and excessive stresses; pinching.	Mechanical strength; toughness.	Slags and fluxes; character of the material in joints; insulation of refractories; no provision for expansion; thin joints.	Vitrification, shrinkage; nature of bond; structure; degree of firing; accuracy of shape.	Rapidity and range of thermal fluctuation; contamination by slags and fluxes; tightness of joints; previous vitrification.	Degree and uniformity of reversible thermal expansion; heat transfer; elasticity; plastic flow.

pand when heated. If the portions of the brick which are heated are not free to expand, a tremendous pressure will build up. This pressure will readily break off the ends of brick to relieve the strain. It is sufficient to cause arches to raise and has been known to cause serious damage in large furnaces. The diagram of Fig. 1 shows what happens when an arch expands. The increased pressure on the inner ends of the brick often causes a few brick or even a layer to be pinched off. In laying up an arch it is better to have the outer ends of the arch brick fit close than the inner ends. Warped and untrue brick are quite certain to spall, especially when laid up dry in an arch. This is not so apt to happen on imperfect brick when a mortar is used to take care of inequalities.

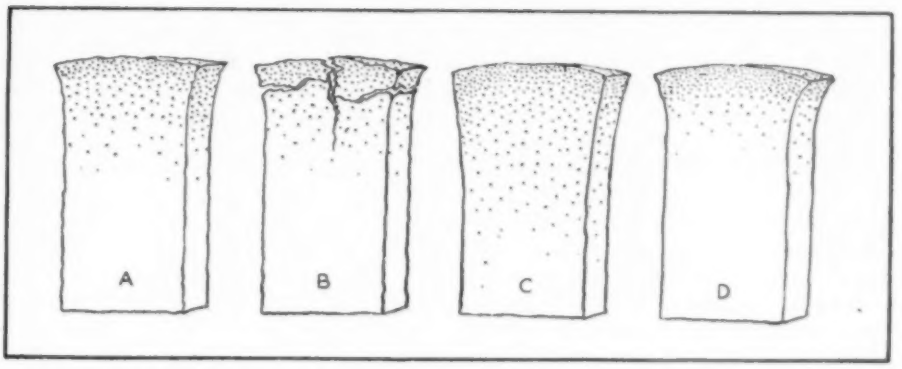


Fig. 3—Shaded portions indicate presence of heat. Expansion of the end due to heat is shown in A. In brick B spalling has occurred because of insufficient elasticity and plastic flow for the thermal expansion which it exhibits. Bricks C and D show the variation in the shape of their heated ends due to difference in thermal conductivity

Allow for Expansion

In sidewall construction a good plan is to insert in the joints at intervals the necessary thickness of cardboard, which will burn out leaving a space for expansion. The space necessary for the brick to expand can be figured from the coefficient of expansion of the brick in question. For example, suppose the coefficient is 0.000006 (which means that a unit of length will expand 0.000006 part of its length for each degree Cent.); then at 1000 degrees Cent. the expansion would be 0.000006 x 1000 = 0.006 of the length. For a section of wall 10 feet long, the linear expansion would be 0.006 x 10 feet = 0.06 feet or about ¾-inch. Part of this expansion would be taken up in the joints between the brick, so that provision is only necessary for a portion of the actual expansion.

As a rule, brick laid up with thick joints have more space to expand because most joint material has some shrinkage. Thin joints are desirable from the refractoriness and slag point of view, but should be used with precautions for the reasons mentioned above.

The heading of "structural spalling" intends to cover a type of action which is not generally known or considered. Most refractory materials undergo a marked change in their structural or physical properties after prolonged use. After long exposures to high temperatures and slags or fluxes, the brick invariably become vitrified to a certain degree. Accompanying this vitrification usually is a permanent change in the dimensions of the exposed portions. If the expansion or contraction, as it may be, is excessive, a tendency toward a separation between the original and heat treated portions will be noted as shown in Fig. 2. The seriousness of this action depends upon a number of properties. The expansion or shrinkage may proceed to a considerable degree without any evidence of separation. A gradual transition from the altered to the unaltered portions will reduce the tendency toward cracking or separating while pronounced shrinkage of a given section is apt to cause the severing of the dissimilar portions.

It often is exceedingly difficult to distinguish between structural spalling and spalling produced by thermal shock. Studies of the behavior of various types of clay refractories indicate that the structural causes play an important part in most conditions of spalling and many grades of clay brick are known to spall more rapidly from this cause than from pure thermal shock. Differentiation between structural and thermal spalling is necessary because the means of correcting each type are dissimilar. This is especially true in view of the common occurrence of the structural, which is mistaken for the thermal type.

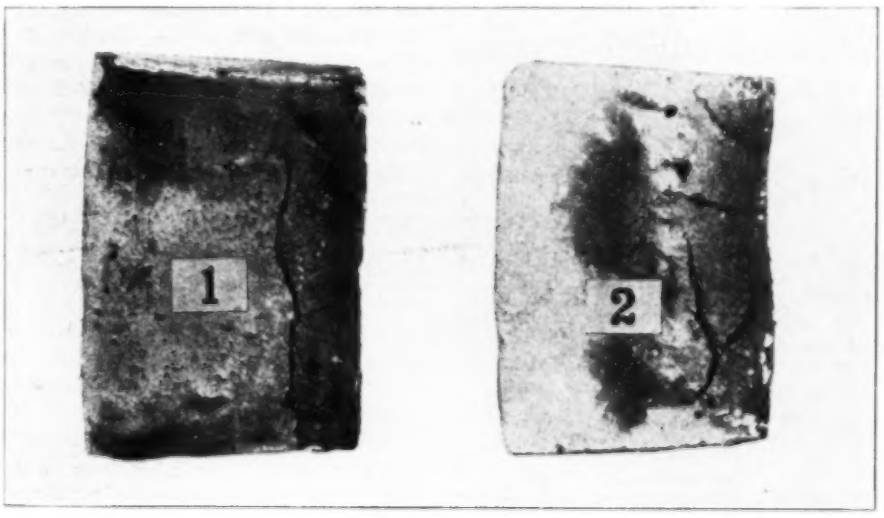


Fig. 2—Kiln liners taken from service, which show the progress of structural spalling. These shrinkage cracks would soon lead to a serious spalling condition

Shrinkage Is Leading Factor

Shrinkage is the main cause of structural spalling; therefore, conditions such as slagging or fluxing which may be present within the furnace will hasten the action. Unnecessarily high temperature in some operations results from the insulation of the walls, which is conducive to shrinkage or spalling. Open joints, caused by shrinkage or the melting away of unsatisfactory mortar, are serious because they allow the heat to come in contact with a larger area of the brick, thereby heating the face to a greater depth and to a higher temperature.

Brick that do not show marked tendencies toward shrinkage in a given furnace operation are naturally the most resistant to this spalling. Refractoriness is not necessarily the

criterion for resistance, since diaspore brick are apt to exhibit this type of failure. Constancy of volume, accompanied by refractoriness, is highly desirable, since the more refractory body will be less susceptible to action of fluxes, which accelerate shrinkage. Contrary to the usual belief, spalling may be reduced in certain cases by employing a harder fired brick, which would reduce the shrinkage in service.

Thermal spalling, which is due to rapid temperature changes, is the type most commonly considered. In a number of kinds of refractories, for example, silica, chrome and magnesite, it is the all important variety. It is the most difficult to prevent from the producer's point of view, since it is caused by certain properties of the brick which are exceedingly difficult to alter. As previously mentioned, brick expand when heated and likewise contract when cooled. A brick is a rigid body and in order to conform to the increased size of an expanded portion, several conditions must be met. For example, in Fig. 3, the heated end of *A* could not have assumed its shape and still have been part of the brick unless certain portions were elastic or plastic. If the brick did not possess properties which would allow such a change in dimension, the heated or expanded section would crack away from the remainder as shown in *B* of Fig. 3. This often happens in refractories which spall by thermal shock.

Permits Rearrangement

A brick having sufficient elasticity could not be spalled by any thermal shock. The expansion and contraction of sections heated and cooled would be taken care of through the elasticity. A brick as elastic as rubber could not be spalled. Likewise the property of elastic flow, such as tar exhibits, would allow a rearrangement of the brick structure so as to conform with the effects of rapid heating and cooling, thus preventing spalling. Clay brick have been studied to learn of the presence of these properties and it has been shown that they are elastic up to about 800 degrees Cent. and at higher temperatures they show a plastic flow. Naturally these properties are present only to a small degree since if it were possible to increase the order of their presence, thermal spalling could be overcome.

Another factor is that of the thermal conductivity of the brick. One having a high rate of heat flow would not allow as great a difference in temperature to exist between sections as one of lesser efficiency. Brick shown in *C* and *D*, Fig. 3, exhibit these properties. The order of importance and role of each of these factors have not been studied sufficiently to disclose all of their importance and value. Little appears that can be done to materially increase the thermal spalling resistance of most brick. Soft firing and an open structure help in certain kinds of service. A careful selection of raw materials is often an assistance and the blending of clays having approximately the same thermal expansion is favored over those which show appreciable difference in their coefficients. Open-burning clays are more desirable than those which readily vitrify, especially in the case of the plastic or bond clay. Coarse, splintery particles for grog are advantageous.

Heat Affects Lining

In some furnace operations the rate of heating or cooling of the lining is sufficient to cause excessive thermal spalling of silica, chrome and magnesite brick. The high expansion of silica brick at certain temperatures makes them sensitive to quick changes of temperature and often this expansion can be altered in a measure by developing in them the desired physical forms of silica. The reversible expansion of most refractories cannot be altered in any way.

It is believed that the effects of rapid temperature changes upon clay refractories have been over-emphasized. The spalling which does occur results from other causes equally as important as that of thermal shock. The general problem is not a simple one with so many factors involved and especially when they interact as they often do. The appreciation of the condition and properties which are involved should be helpful to manufacturers and users of refractories in combatting the common and destructive spalling action.

NewEnglandFoundrymen Hold Boston Meeting

The regular September meeting of the New England Foundrymen's association was held Sept. 12, at Boston. J. R. Linney, vice president of the Chateaugay Ore & Iron Co., Lyon Mountain, N. Y., was the chief speaker. His subject covered the various processes of mining, sintering, and smelting of ore. Another paper by H. A. Lincoln and James Prendergast, Sullivan Machinery Co., Claremont, N. H., covered the hydraulic process of cleaning castings.

J. R. Baumberger has been added to the personnel of the Dallas, Tex., office of the United States Electrical Tool Co., Cincinnati.

Conserve Man Power by Eliminating Steps

(*Concluded from Page* 802)

from the upper end of the shop to the cupola. To make this possible, a branch track with a switch leading to the main monorail has been constructed. The branch track leads behind the cupola, and the switch which is operated by the crane operator is arranged so that the action is positive, and eliminates any possibility of the crane running off the track. The cupola is charged mechanically by a charging crane manufactured by the Whiting Corp. This crane is mounted on rails which extend from the cupola to a large square opening in the charging floor. The crane operator lowers a hook through the opening and picks up the bottom dump, circular steel buckets which contain the metal and coke for the charges.

Charges are weighed on scales supplied by the Toledo Scale Co., Toledo, O. The scales are direct reading, dial type and the platforms of the scales are placed below the floor level so that when buckets are placed on them, the top of the bucket is slightly above the floor. This facilitates loading the buckets. Charges weigh 4000 pounds.

When the proper amount of material is placed in the bucket, the crane operator lowers the hook through the opening in the floor and engages it in the ring in the center of the bucket. He then hoists it up about four feet above the charging floor and moves it into the cupola which has an opening in the side large enough to accommodate the bucket. The operator then lowers the bucket until it rests on a ledge inside the cupola even with the bottom of the charging door. This ledge supports the rim of the bucket and allows the doors which are hinged in the center to open, and discharge the contents into the cupola. The doors are closed and latched as the bucket is raised from the ledge.

This is the second of a series of articles describing operations at the Bond plant of the American Radiator Co., Buffalo. The first appeared in the issue of Sept. 15. The third will appear in an early issue.

According to a paper entitled "Fluorspar and Crylite in 1927" issued by the bureau of mines, the foundry industry used 4.03 per cent of the fluorspar produced, in 1927 a loss of 0.80 per cent from 1926. Illinois and Kentucky were the chief producers for this industry. The fluorspar shipments were 13 per cent less in 1927 than in 1926.

How and Why in Brass Founding

By Charles Vickers

Wants Bell Mixture

Can you advise us as to the composition of church bells, giving the ratio of each metal in the mixture and the cost per pound of the raw metals entering into the same?

Church bells are made of copper and tin alloy, the standard proportion being 78 per cent copper, 22 per cent tin. Bells of Cologne cathedral were made of this mixture and so were the bells of Denver cathedral. Small amounts of other metals are sometimes added as deoxidizers and probably the best of these are silicon and iron. About 0.5 per cent of 10 per cent silicon copper will insure freedom from porosity in the case of such castings. The price of the metals fluctuates. Consult "Trade Trends in Tabloid" in THE FOUNDRY for correct market prices of non-ferrous metals.

Casting Bronze Tablets

We are looking for some information regarding the casting of bronze tablets: What kind of a flux would you recommend in melting the bronze for tablets? At what temperature should the metal be poured? Is French sand suitable, or is there a finer sand adapted for this purpose? Is it better to tamp the sand in the drag, or to hold a riddle some four or five feet above the pattern and screen on the sand? What special tools are used in finishing tablets by hand?

Use of a flux depends on the method of melting, the kind of furnace, and the time of melting. Thus for a crucible furnace with coke for fuel, use charcoal, for a crucible furnace using oil fuel, rapid melting, use no flux. The pouring temperature is governed by the thickness of the casting and its weight. A thick, heavy casting is poured at a lower temperature than a light, thin casting, and skilled control of temperature is required. Between 2100 and 2200 degrees Fahr. is a good range of pouring temperature.

Suitability of French sand is a question that is a matter of opinion. Some founders of tablets prefer to use it and others do not. What is wanted is a facing sand that is porous, tough and will give a surface perfectly uniform. Otherwise a smooth casting cannot be made. Tamp, or not to tamp never has been definitely settled. The important matter is to avoid *ramming away*; that is shifting the facing on the pattern after it has taken the impression. This is a fatal defect and can be avoided on all moderate size tablets by first ramming firmly around the sides of the flask to prevent the sand layer after ramming, from sliding sideways away from its impressions and spoiling the mold.

Ramming the sand by dropping from a screen is a good way, but a four or five foot drop is hardly sufficient. Those who practice this method of ramming usually erect a stage over the mold from which the sand is dropped onto the face of the pattern. Skin drying such molds has some advantage over baking. The mold need not be disturbed when it is skin dried, so any danger of cracking the impression is avoided. However, a skin dried mold should be poured before the moisture can strike back to the face, otherwise, the skin drying has been in vain. Where the lettering and scroll work is deep and there are many little ridges and cores of molding sand, there is always danger of washing away, and to avoid this the facing sand should be compounded so that it will bake firm similar to a core. To use the molding sand as received, and simply rely on molasses water for a binder is to take chances of portions being detached by the hot fluid metal.

Recommends Two Alloys

We are making small aluminum castings that have to be threaded with ⅜-inch pipe threads. Would you give us an aluminum mixture that will thread well. We would like to have a mixture for a rifle nut as used in drills and the alloy must be hard and tough. The mixture we have been using consists of copper 90 per cent; tin 6 per cent; zinc 4 per cent, but they give trouble breaking.

For the aluminum alloy use the following mixture: Aluminum, 82 per cent; zinc, 15 per cent and copper 3 per cent. For the bronze use: Copper, 89.50 per cent; tin, 10 per cent and manganese-copper, 0.5 per cent. The manganese copper should contain 30 per cent of manganese and be iron free.

Warp Spoils Aluminum Pan Casting

We have been trying to make aluminum pans ⅛-inch thick, 48 inches long and 20 inches wide, but have considerable trouble with the castings springing into a bow about ⅜-inch at the center. The gates have been put on the bottom in four places and the castings come good except they were so crooked we could not use them. The metal is scrap crank cases and we wonder whether you could give us some enlightenment as to how they should be poured to have them come straight?

This is an old, old difficulty in foundries and a long article can be written on the subject. Boiling it all down, however, the best way out of the difficulty has been found by experience to so make the pattern that it will produce a straight casting. The pattern used is given *camber*, that is it is made crooked instead of straight and the contraction of the metal as it solidifies pulls the casting straight. This involves a little calculation, but is the only way to proceed in the case of alloys having no elongation as they would break if attempts were made to straighten them.

Changing of the pattern can be avoided if a metal is used that will bend; because in such a case the sprung casting can be straightened. Therefore, in the case of this aluminum casting the easiest way out of the difficulty might be to use another alloy; one that might be more expensive, but could be bent back to ing.

For example one of the silicon aluminum alloys would enable this to be done, such for instance as the 13 num alloys would enable this to be done, such for instance as the 13 per cent silicon, 87 per cent aluminum alloy. It probably would be advisable to purchase the alloy in ingot form rather than to make it in the foundry, as difficulties might be encountered by anyone making such an alloy for the first time. The silicon makes a nice casting alloy, once it is properly introduced. While it is possible the casting might come straight using such a silicon aluminum alloy, this would not be important as it could be easily straightened without much difficulty with the proper tools.

Reduces New Sand Requirements

A Set of Screens and a Fan Remove All the Useless Material from Each Batch of Sand Which Then Is Renewed by the Addition of Clay

By H. A. Mason

THROUGH the development of mechanical sand handling devices and the tremendous strides made in sand quality control, the sand preparing department has kept pace with high-speed production in the foundry by delivering the quantity of sand desired to any particular molding floor. This sand in most foundries is more uniform and of a better quality than that prepared by the molder in the old days when part of his time was given over to the preparation of his sand.

Having solved the problem of delivering sand to the foundry continuously and in large quantities, and at the standard of quality demanded by the foundry foreman, attention was turned to the fact that molding costs were mounting due to the increase in the cost of new sand.

During the past few years much has been written on the subject of economy and reclamation of steel foundry sands and many tests have been carried out by eminent engineers and foundry experts. The field, therefore, is not new, but one which generally has been neglected by the men in the foundry, core room, and on the sand mills, who actually use the sand and to whom careful investigation of the use of reclaimed sand should serve the most as reflected in greater operating efficiency and consequently lower costs in their respective related foundry departments.

As in most steel foundries, former practice at the plant of the Gould Coupler Co., Depew, N. Y., was to use as much sand as was thought necessary to insure castings free from defects and of good appearance. A fairly thick layer of new sand facing was placed next to all patterns and this facing sand was backed up with well prepared heap sand. This method, of course, gave uniformly good results, the percentage of defective work was low and the appearance of the castings was above the average.

In the coreroom a great majority of the cores were faced with new sand and good results were obtained from this source of so many of the troubles encountered in the foundry. New sand consumption in pounds per net ton of good castings was high and the money spent for new sand and the removal of waste sand from the shop, over the period of a year, ran into a tremendous amount. It was plainly apparent that a reduction in the amount of new sand used in the shop would result in a considerable saving in operating costs.

An analysis of the use of new sand in the foundry and the core room revealed that the bulk was used in facing for both molds and cores, and in the large amounts added to the heap sand pile to increase the permeability of this sand.

Problem of reducing new sand consumption consisted, therefore, of two parts:

1. That of providing a sand which would give as good results as sand facing made from new sand.

Results Obtained

FROM a paper presented before the recent convention of the American Foundrymen's association in Philadelphia, May 14-18. The author, H. A. Mason, is assistant superintendent Gould Coupler Co., Depew, N. Y.

Through the use of reclaimed sand bonded with a highly refractory durable clay, economies have been effected greatly in excess of anticipation when experiments started. New sand consumption has been reduced from 1200 to 300 pounds per ton of good castings. Clay consumption has dropped from 150 to 80 pounds per ton of good castings produced. On an original investment of $3000 for sand reclaiming equipment and a small additional cost for clay, the monthly savings amount to $3500.

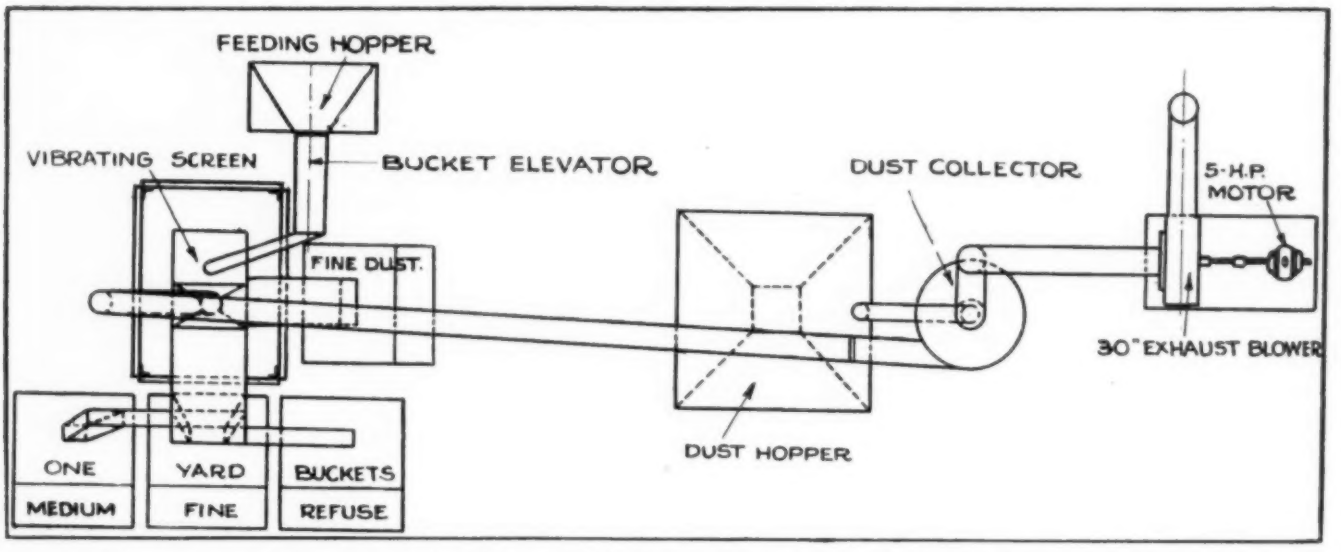


Fig. 1—General Layout of the Sand Reclaiming Equipment as Finally Designed and Operated

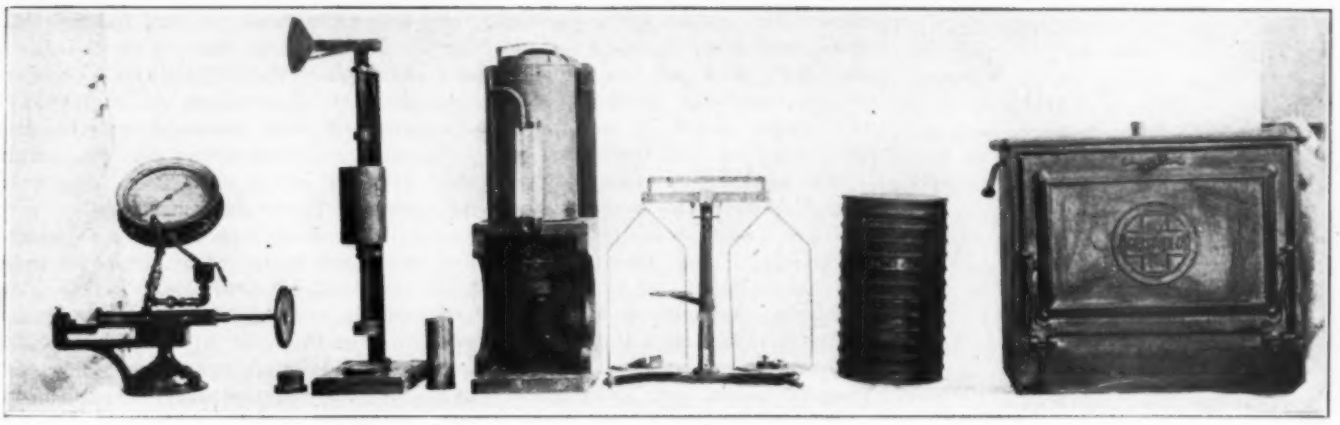


Fig. 2—Sand Control Apparatus Included Left to Right: Compression Strength Machine, Rammer, Permeability Machine, Balance, Sieves and Gas Oven

2. That of providing a heap sand which will not close up and require the addition of new sand to open it up or raise the permeability.

Facing

Attacking the first part of the problem, it was realized that the sand in a mold, especially that portion next to the casting, is subjected to severe usage. Due to the intense heat of the molten steel, which sets up tremendous stresses in the individual grains of sand, these are split into smaller particles. The bonding materials, such as clay, and manufactured bonds, are also affected by the high temperature. The clay nearest the casting is burned out or dehydrated and loses its plasticity and in this state is useless for rebonding. If used in subsequent sand mixtures it only serves to fill the voids between the particles of sand and in this way decreases the permeability. However, only a small percentage of the total quantity of sand in a mold is directly affected by the intense heat. The major portion of the sand in a mold still retains its original qualities and therefore could be used repeatedly if some means of removing the burned out sand and recovering the good sand could be devised.

Several years ago the Gould Coupler Co. began an intensive investigation of methods of sand reclaiming. After experimenting along many different lines and thoroughly going over methods used by other plants manufacturing a similar product, a process embodying the principles of removing the vitrified or split grains of sand by screening and the dehydrated or burned out bonding material by air suction was developed.

The first step in developing the sand reclaiming process took the form of exhaustive durability tests of both sand and clay. These tests were based on the theory that all that is necessary from a practical standpoint in the reclaiming of sand is to remove, in the cheapest manner possible, the vitrified or split grains of sand and the burned out bonding materials which have come in actual or close contact with the hot steel, and having done this, mix the reclaimed sand with a highly refractory durable bonding agent together with that amount of new sand necessary to keep the amount of sand on hand in the foundry constant, until it possesses the necessary properties required for the class of work to be done.

The equipment used in the tests consisted of a miniature sand reclaiming unit, made by the National Engineering Co., Chicago.

Tests on Clays

Realizing that clay bond would play an important part in any sand reclamation program, preliminary tests were run on several kinds of clay. By the process of elimination all but two of the clays tried were found unfit for our use in this work. The first of these clays, which we will call clay A was a comparatively cheap, fat colloidal clay with a fusion point of 2800 degrees Fahr. The rating of clays by the bureau of standards places clay A near the top range of average foundry clays. The second clay, which we will call clay

Table I

Results of Comparative Durability Tests

Mix. No.	—Lbs. Clay Used— Clay A	Clay B	Strength Facing Sand A	Strength Facing Sand B	Strength Heap Sand A	Strength Heap Sand B	Permeability Facing Sand A	Permeability Facing Sand B	Permeability Heap Sand A	Permeability Heap Sand B	Moisture Facing Sand A	Moisture Facing Sand B	Moisture Heap Sand A	Moisture Heap Sand B
1	55	31	1.1	1.1	1.1	1.1	167	142	167	142	3.1	3.8	4.2	4.0
2	None	None	1.0	1.2	0.9	1.1	156	151	142	146	3.4	3.4	4.4	4.0
3	None	None	1.1	1.0	0.9	1.0	156	173	146	156	3.0	3.2	4.2	3.8
4	4	None	1.0	1.2	0.8	1.0	205	163	138	156	3.0	3.8	3.8	4.2
5	None	None	1.1	1.2	0.9	0.9	146	173	128	151	3.6	3.6	4.0	4.4
6	6	4	1.1	1.0	0.8	0.9	178	173	134	163	3.8	3.6	4.0	4.4
7	6	4	1.1	1.1	0.8	1.0	142	178	126	163	3.7	3.4	4.0	4.2
8	4	4	1.4	1.0	0.8	1.0	167	178	134	167	3.6	4.7	4.4	4.0
9	4	None	1.0	1.2	0.7	0.9	163	156	138	163	4.4	3.7	4.6	4.4
10	6	None	1.2	1.2	0.7	0.9	151	163	138	156	4.4	3.2	4.2	4.0
11	14	4	1.4	1.0	0.6	0.8	193	205	138	151	4.2	3.8	4.0	3.8
12	6	3	1.2	1.1	0.7	0.7	178	193	142	156	3.6	5.0	4.2	3.6
13	6	6	1.3	1.1	0.6	0.9	163	219	134	163	3.6	3.4	4.4	4.2
14	6	4	1.3	1.1	0.6	0.9	212	212	134	167	3.8	3.2	3.8	4.2
15	4	4	1.1	1.0	0 6	0.8	173	219	128	156	4.2	5.0	4.0	4.0
16	4	4	1.2	1.1	0.5	0.8	163	205	128	151	4.2	3.8	4.2	4.4
17	6	2	1.1	1.0	0.4	0.8	178	235	126	151	3.6	3.5	4.4	4.0
18	4	6	1.2	1.0	0.4	0.9	156	185	122	142	3.6	4.0	4.0	4.2
19	4	4	1.0	1.4	0.4	0.9	163	185	122	146	3.8	3.8	4.2	4.2
20	6	4	1.1	1.2	0.3	0.9	185	173	119	146	3.4	4.2	4.2	4.0

Table II

Test Results

Type of Clay	Clay A	Clay B
Number of mixes cast against	20	20
Pounds of clay used	145	85
Average strength (facing sand)	1.1	1.1
Average permeability (facing sand)	164	170
Average moisture (facing sand)	3.7	3.8
Strength of heap sand at end of test	0.3	0.9
Permeability of heap sand at end of test	119	146

B, was a comparatively high priced, hard, lean, highly refractory clay with a fusion point of 2950 degrees Fahr. The fusion points of the two clays, as quoted, were determined by the Mellon institute of Pittsburgh.

To determine the relative values of these clays in a process of sand reclaiming, such as we contemplated, a comparative durability test was made.

A wood floor was laid in one corner of the shop and this was covered with sheet tin to guard against the introduction of any foreign material. Each piece of the equipment used in the test was placed upon this floor.

A small hand flask was used with a small pattern requiring no cores. The ratio of the weight of sand in the flask to the weight of the casting was maintained at 8 to 1, which is the approximate average ratio in the day to day practice in this foundry.

New silica sand was selected and mixed with the necessary bonding materials until it possessed the physical and chemical properties of our No. 1 new sand facing. A careful check was made of the weight of sand and bonding material used in the first and all subsequent sand mixes, the total weight of the mixture being about 50 per cent above that required for the mold.

The mold then was rammed and transferred to the pouring floor. After the mold was poured, it was returned to the space allotted for the experiments and shaken out.

Surplus amount of sand not used in the first mix was thoroughly mixed with the returned sand and the same amount taken out as representative of the condition of the heap sand after one cast had been made. This operation was repeated on each mix and in this way a careful check of the condition of the heap sand was kept throughout the test.

Remainder of the sand, to save time between mixes, was dried and run through the reclaimer where the vitrified or burned out material in the form of flakes or scales and the dehydrated clay and other bonding material was removed. The good sand, after cooling, was weighed and the loss in weight caused by the removal of the vitrified sand and dust in the reclaiming process was made up by adding new sand.

This mixture, representing theoretical reclaimed sand facing, was put into the mixer; sufficient moisture was added and after milling for 6 minutes, tests of permeability, strength and moisture were made. Any decrease in strength below the minimum figure used in facing sand in the foundry was made up through the addition of dry clay to the mixture. After each addition of clay to any one mix, new values of moisture, strength, and permeability were determined and recorded for reference.

In the same way, with the exception that the milling time was reduced to 3 minutes, the permeability, strength and moisture of the heap sand, as represented by the surplus of sand after each cast, was taken and tabulated for each mix.

This same procedure was repeated over the period of 20 cycles or mixes for each kind of clay, in each mix adding only that amount of new sand needed to make up the loss through the reclaiming operation and recording the permeability, strength and moisture values of both facing and heap sand after each mix.

Condition and appearance of the castings also were watched closely on each succeeding mix and any difference noted. The tabulated results of the test are given in Table I.

Analysis of Tests on Clays

A summary of the results as tabulated in Table I reveals the salient points as given in Table II.

An analysis of the summary of Table II shows that with our system of reclaiming we were able to maintain a high permeability in our facing sand, using either clay A or clay B. Therefore, the conclusion is that our principle of reclaiming is fundamentally sound, notwithstanding the fact that almost twice the amount of clay A was used over clay B, we were able to remove the inert material and so preserve a good open facing sand.

Analysis of the results in regard to heap sand reveals that our theory was correct. A highly refractory durable clay is necessary in the success of any comprehensive program of sand reclaiming which has for its

Fig. 3—Miniature Sand Treating Equipment Was Set Up on a Special Floor and Included a Sand Dryer, Reclaimer and Muller

object the substantial decrease of new sand consumption.

As shown in the tabulated results of the test, the permeability and strength of the heap sand using clay A had dropped at the end of the test to 119 and 0.3 respectively. The drop in permeability and strength of the heap sand would mean that sooner or later the foundry foreman would report that his heap sand was too close and as in a great many steel foundries, a carload or two of new sand would be run into the foundry on Saturday night or Sunday when the cranes are not busy, and unloaded and scattered over the heap sand pile. The addition of new sand, which practically has no bonding strength, to the heap sand pile would mean that the strength of the heap sand would be still further lowered and this fact would call for the addition of clay in the mulling operation of the heap sand, thus increasing the mulling time per batch, which in our case is a vital cog in our scheme of high-speed production of steel castings.

Heap sand taken from mixes using clay B shows permeability and strength values of 146 and 0.9 respectively. From these results it is apparent that in using clay B as a bonding agent, a smaller amount of dehydrated or inert material is deposited in the heap sand, thus keeping it open, and it naturally follows that if a smaller amount of dehydrated material is deposited, there must be a greater percentage of good plastic bond available for use. This point is apparently proven in the 0.9 strength value of the heap sand at the conclusion of the test using clay B.

Application in Production Work

The castings, at the end of the test using clay B, showed a uniform quality. The sand did not burn in and it peeled readily from the casting, which condition would make for lower cleaning costs. In the case of clay A, probably due to a lower vitrification temperature, the castings started to burn in after the twelfth mix and were generally of a rougher appearance than the castings made from mixes using clay B.

Laboratory tests, of course, mean nothing if the results obtained from them cannot be practically applied to the daily routine in the foundry.

The results gained through this series of experiments at least looked worthy of a trial. With these results as a base upon which to build a sand reclaimer capable of turning out 100 tons of reclaimed sand per 24 hours, was built at an initial cost of $3000. This machine was placed on the flogging or trimming floor where the molding sand adhering to the castings and the core sand which is knocked out of the castings by the knockout hammers is readily available. This sand is bucketed and scraped in close proximity to the reclaimer by the overhead crane and from this point is shoveled by hand onto a heavy large mesh screen. This screen removes any rods, wires, nails or steel trimmings which may be in the sand. The sand, free from all metallic substance, is discharged down a chute and empties into a bucket elevator which carries the sand to the top of the reclaimer where it is dumped on the vibrating screens.

The design of the reclaimer, as in the miniature unit used in the tests, called for the removal of the vitrified or split grains of sand by screening and the burned out bonding materials by air suction.

Three vibrating screens are used in the reclaimer arranged in triple deck fashion, one on top of the other —all inclined at an angle of about 30 degrees. The top screen, which removes the scale, flakes and lumps of vitrified sand and bond, is 8 mesh and the second screen is 20 mesh. The third is a 35 mesh screen. Suction is provided by a fan driven by a 5-horsepower motor.

Dust and dehydrated material drawn from the reclaimer is deposited in a cyclone dust arrester and from there is dumped periodically into a railroad car and taken to the refuse heap.

Sand and refuse from the reclaimer are drawn off in four different directions. Scale, flakes and lumps from the top screen, good sand from the second and third screens, and the split grains of sand and dust not removed by suction, through the 35 mesh or third screen.

Good sand retained on the 20 mesh and 35 mesh screens is taken directly to the foundry and coreroom for use in facing sands. The refuse retained on the top screen and that through the third screen is unfit for use and is loaded into a car and taken to the dump.

Following the erection of the reclaimer, further tests were made using the reclaimed sand on different types of castings. The results of these tests were so satisfactory from a sand quality and a casting quality standpoint that without fear of serious consequences, the reclaimed sand was introduced into all molding and core sand facing mixtures. Only that amount of new sand is used which is required to make up the loss of sand which cannot be reclaimed, in this way keeping the amount of sand constant in the foundry.

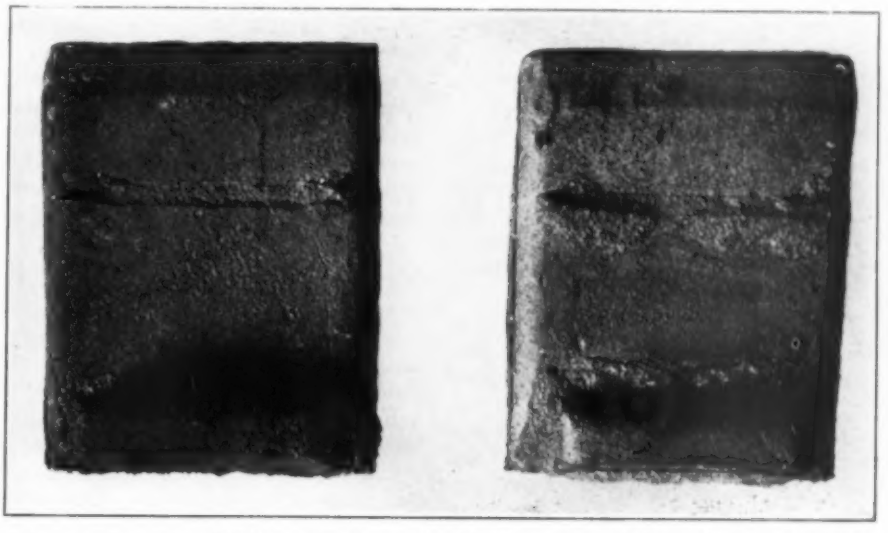


Fig. 4—Left to Right: Castings Made from Twentieth Sand Mix With Clays A and B

Holds Conference on Industrial Heating

The engineering extension department of Pennsylvania State college will hold its second conference on industrial electric heating in State College, Pa., Oct. 24-27. A series of meetings for practical men will be devoted to the consideration of the uses of electric heating in the ferrous and nonferrous industries. Specialists will lead discussions on the new developments in electric melting of gray iron, brass, manganese, and alloy steels; on annealing, carburizing, heat treatment, and on the various types of furnaces. Many of the talks will be illustrated.

Metals and Melting

How Metallurgical Problems Have Been Solved in Gray Iron, Malleable and Steel

Relation of Tuyere Area to Cupola Section

Question: We operate a 38-inch cupola with six tuyeres 9 x 4 inches at the shell and 14 x 4 inches at the face of the lining. *A* admits that the area of the mouth of the tuyeres is in correct proportion to the cross sectional area of the cupola at the melting zone, but he claims the openings in the shell are too small. *B* claims that so long as the opening in the tuyere next the charge is the right size, the size of the opening at the other end does not matter.

Answer: According to the usual method of reckoning the size of the tuyere area, *B* is right. The size of the opening where the air finally escapes into the furnace is the most logical place to take a measurement for purpose of comparison. In fact the method has been adopted almost universally and is regarded as standard for purpose of comparison. Viewed purely in an academic light *A* has certain grounds on which to support his argument, but since operating a cupola is an intensely practical problem, we must confine ourselves to practical views. A 38-inch cupola has a cross sectional area of 1134 inches. Six tuyeres 14 x 4 inches at the mouth present a combined area of 336 inches, approximately one third of the cupola area. This proportion represents the average in cupola construction.

Suitable Iron for Grate Bars in Boilers

Question: What is the best grade of iron for grates that are used under steam boilers?

Answer: From the standpoint of service, the best grade of iron to put in furnace grate bars is what is known as bessemer iron, that is an iron in which the phosphorus and sulphur content are considerably lower than in any other kind of iron made in a coke fired blast furnace. Charcoal iron also is exceptionally low in these elements and if expense is no object, may be used. In fact this expense factor is the one which wrecks nearly all the foundryman's plans. You can't put 5-cent iron into a casting and sell it in competition with a casting made from 3-cent iron. Unfortunately, the average customer does not want to be shown. The promise of a longer life with an expensive casting is discounted by the present low price at which other castings may be secured. Grate bars at a reasonable cost, and castings that will meet all ordinary requirements conform to the following approximate analysis: Silicon 1.25 to 1.75 per cent; sulphur 0.06 per cent, phosphorus 0.20 per cent; manganese 0.60 to 0.80 per cent. A dose of steel in the mixture will help to secure these figures, also a low total carbon. This metal must be melted exceedingly hot, otherwise the discount will be heavy from missrun castings.

Run Continuous Heats in New Cupolas

Question: We are installing two new cupolas with the intention of operating one continuously on alternate days. Each one is lined to 48 inches and is provided with two sets of tuyeres, six to a set. The lower tuyeres, 17 inches above the bottom are 11 x 5 inches, the upper set 10 inches higher are 4¾ x 3¾ inches. The slag hole is 15 inches above the bottom. Air from a positive pressure blower is driven through a main pipe 20 inches in diameter which forks above the cupola and delivers air to the wind box through two branches. Would you suggest any changes in cupola arrangements before starting continuous melting?

Answer: According to your description your two new cupolas are of standard design and therefore no special features require any particular attention. The only difference between running an all day heat and one for a couple of hours is that you will have to use lighter charges. For example 1000 pounds of iron to a charge probably will be enough for a 48-inch cupola running all day. On a short heat of one or two hours the charge easily may be 3000 pounds.

If you are familiar with cupola operation, you will find no material difference between running a heat for two hours or for 10 hours. If you are not familiar with the details we suggest you procure a copy of the *Foundryman's Handbook*, which may be ordered through THE FOUNDRY for $5. It contains a full description for preparing the cupola for a heat.

Iron for Jobbing Work

Question: What would you consider the proper analysis of cast iron for making a good mixture for general jobbing and machine shop work, that would be easily machined?

Answer: For general jobbing work you should have an iron containing less than 0.1 per cent sulphur, between 0.4 and 0.6 per cent phosphorus and between 0.5 and 0.7 per cent manganese. The silicon should be around 2 per cent. If you are making a lighter grade of work the silicon should run a little higher than this, possibly as high as 2.50 per cent for extremely light work. For heavy work, that is sections 2 inches thick or more, the silicon may run down as low as 1.5 per cent. To get such a cast iron from a mixture of pig iron and returned scrap it would be necessary to have the silicon 0.4 to 0.5 per cent higher in the pig iron than you desire in the cast iron. Manganese also should be somewhat higher, about 0.2 per cent. Phosphorus will come the same in the casting as in the pig iron, but sulphur will be increased by the sulphur in the coke. Pig iron is usually bought with a specification of less than 0.05 per cent sulphur.

Excessive Flow of Slag Caused by Flux

Question: We run a 5-ton heat through a 38-inch cupola in one hour and find that an excessive quantity of slag forms in the early part of the heat and continues running through a slag hole at the back of the cupola until melting ceases. What is the cause of this and can it be prevented?

Answer: Your inquiry is in radical contrast to the usual style of inquiries that arrive at this office on the subject of cupola operating conditions. Other inquiries are in despair because their cupolas bung up before the heat is over. They cannot get the slag to run *out*. According to your complaint you cannot keep the slag *in* the cupola.

So long as coke is burned in a cupola at a temperature that will melt iron, the ash in the coke will be reduced to a liquid known as slag. This liquid is thick and viscous and rapidly solidifies when it leaves the

melting zone or comes into contact with the blast. For a short time it does not interfere with the operation of the cupola, but gradually it accumulates and by building in from the lining toward the center it reduces the area of the melting zone and thus retards the speed of melting. The length of time a cupola may be operated without the addition of a fluxing agent depends to a great extent on the character of the coke and the iron. It is apparent that a cupola will run clean for a longer time where the coke is low in ash and where the iron is clean, than it will where these conditions do not obtain.

The addition of limestone to the charge increases the amount of slag, but it also renders it sufficiently fluid to flow through the slag hole provided for the purpose. Obviously if you wish to prevent the formation of liquid slag, you only have to stop using limestone. The amount of work involved in chipping the cupola next day will indicate which course is preferable.

Gives Industrial Talk

The Chicago Foundryman's club held its first winter meeting at the City club, Chicago, Thursday evening, Sept. 13. The meeting was addressed by W. Harvey Payne, electrical engineer and specialist on electric furnace practice, Western Electric Co., Chicago. The lecture was illustrated and was the first of a series of talks on foundry practice.

Dissolves Partnership

Saunders & Franklin, analytical and consulting chemists, 184 Whittier avenue, Providence, R. I., have dissolved partnership effective Sept. 29. Mr. Saunders will continue in business as Walter M. Saunders, 184 Whittier avenue, and Mr. Franklin as The Franklin Laboratory, 589 Atwells avenue, Providence, R. I.

Hold Fall Meeting

The first fall meeting of the Associated Brass Founders of New England was held Sept. 26, at the Engineers club, 2 Commonwealth avenue, Boston. Pat Dwyer, engineering editor, THE FOUNDRY, gave a talk on "The Foundry, Old and New."

Speeds Production of Large Pattern

AN UNUSUAL record was made some time ago by the pattern shop force at the Sacramento, Calif., general shops of the Southern Pacific company in building a special pattern for a cylinder on one of the P-8 class locomotives in a remarkably short time. The speedy work of the patternmakers prevented the locomotive from being out of service any great length of time.

An average of 17 men working 13 days turned out the finished pattern, which under normal conditions would have taken two men about 110 days to complete. While the actual number of hours spent in building the pattern for the cylinder were practically the same as would have been required under normal conditions, the fact must be taken into consideration that where two men understand this work is little confusion results, but where a great many men are working on the job extra care must be exercised to prevent errors.

The work was accomplished in an efficient and accurate manner. After the pattern was sent to the foundry for casting, no trouble was encountered in drawing the pattern, etc.

Material necessary in the building of this pattern, included: 2254 feet of 3-inch lumber; 50 pounds of nails; 50 pounds of glue; 6 gross of screws; 4 gallons of shellac; 21 separate pattern pieces and 22 coreboxes.

The pattern, coreboxes and the men doing the work are shown in the accompanying illustration. The men shown in the illustration are as follows: 1. G. R. Johnson, patternmaker; 2. J. E. Tusch, loft attendant; 3. C. A. Smith, patternmaker; 4. A. Burzlander, laborer; 5. W. B. De Costa, patternmaker; 6. C. Shalag, patternmaker; 7. C. A. Mott, patternmaker; 8. P. Bertinetti, patternmaker; 9. F. G. Smith, patternmaker; 10. A. L. Grimes, clerk; 11. C. J. Lindstrom, patternmaker; 12. J. V. Rajnus, patternmaker; 13. R. D. Oliphant, patternmaker; 14. R. R. Jensen, apprentice; 15. W. H. Blaney, patternmaker; 16. E. F. Halverson, patternmaker; 17. E. R. Dyer, patternmaker; 18. J. M. Peck, patternmaker; 19. C. E. Hardy, apprentice; 20. L. P. Dickson, helper; 21. W. B. Butler, assistant foreman; 22. G. R. Scott, foreman; 23. J. H. Nelson, apprentice, 24. H. G. Griswell, patternmaker; 25. T. W. Pugh, apprentice.

SEVENTEEN MEN MADE THE LARGE PATTERN AND COREBOXES IN 13 WORKING DAYS

The Shakeout

DAN M. AVEY, Editor

PAT DWYER, Engineering Editor
FRANK G. STEINEBACH, Associate Editor

CHARLES VICKERS, Nonferrous Editor
EDWIN BREMER, Associate Editor

¶ Keep Pattern Records

IN THE good old days, a term that means any time between the past 20 and 50 years, depending on the age of the person invoking evidence from this remote period, the ordinary man regarded his job as more or less a piece of personal property and as a result he treated it with becoming respect and regarded it as his most valued possession. He took his responsibilities and duties seriously and always spoke of his place of employment as *our* shop. Machines, devices or equipment of any kind with which he was connected intimately, he referred to as *mine*.

EVEN among these competent and serious men, the man who had charge of the pattern storage ranked pre-eminent. The ask me another craze was still unknown, therefore a gage of his general intelligence or more properly speaking, general knowledge, was not the subject of common gossip, but his marvelous memory for patterns, was a topic of comment several times a day from one end of the plant to the other. In the course of time, traditions grew up around him and his job and newcomers were told of instances where this man unhestitatingly had brought forth patterns that had not been used for 20 years; of tests in which he had walked blindfold into the pattern storage and laid his hand upon any designated pattern. Claim was advanced that under stress of circumstances and in the dark he could distinguish a pattern by the smell.

A FEW of these walking pattern storage encyclopedias still are in existence, but in this modern age with its multiplicity of forms for recording information, his place has been taken by any ordinarily intelligent person whose only extraordinary qualification is that he can read and write. Every pattern is numbered according to a definite system and every pattern not in use in the foundry is kept in a definitely numbered and indexed space in the pattern storage. The records are kept like any other office records and the foundry is not thrown into a state of wild disorder if perchance the pattern man voluntarily, or involuntarily, severs himself from the pay roll.

¶ Meeting the Competition

WRITERS, economists and leaders of industry during the past few years have been discussing the new competition which the industrial establishment of today must meet. All seem to agree that the most dangerous competition, in reality the new competition, exists between rival industries rather than between plants in the same industry. Attempts are made to supplant an article which a manufacturer and his competitors inside an industry now are selling with a result that the competition between plants within the industry is increased and each fights harder for the fewer number of orders which it is possible to obtain.

UNDOUBTEDLY, this situation has existed in the foundry industry during the past few years. Pressure exerted upon the castings market by other forms of fabrication has been met, in many cases, by price reductions rather than by specific data showing the superiority of cast parts, whether they be steel, malleable, gray iron or nonferrous, for the work at hand. In other words, foundrymen in general have failed to determine the fundamental reasons for these highly competitive conditions before battling for orders, being satisfied to follow the path of least resistance. This has had a tendency more or less to discredit the cost product in the minds of users.

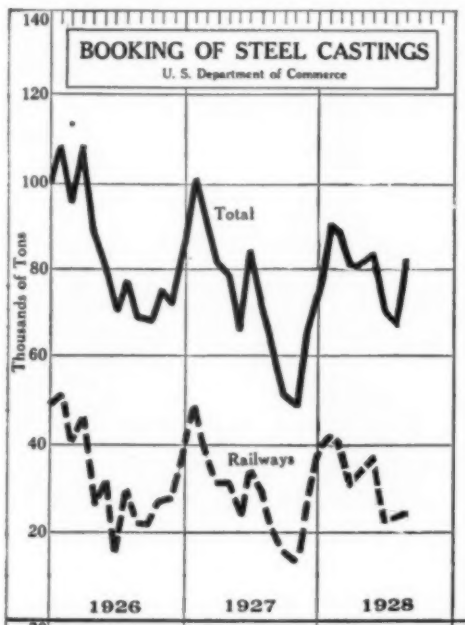
HAPPILY for the industry, this situation is showing every indication of improvement. Groups and individuals now are aware of the propaganda being featured by companies producing engineering materials by various methods of fabrication other than casting. Studies are being undertaken to determine the superiority of cast parts in comparison with the other products. A great amount of valuable information will result from this work. It now remains for the various branches of the industry, associations, and individuals, to co-ordinate the results which are being obtained from the various researches and to unite in a common effort to convince users of the advisability of using castings for purposes in which engineering data prove their greater usefulness.

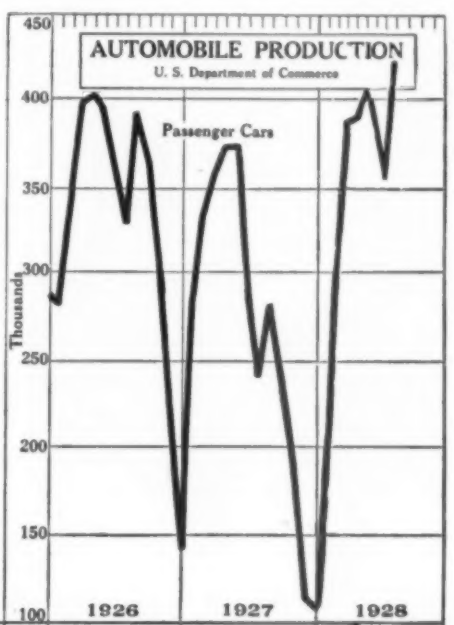
Trade Trends in Tabloid

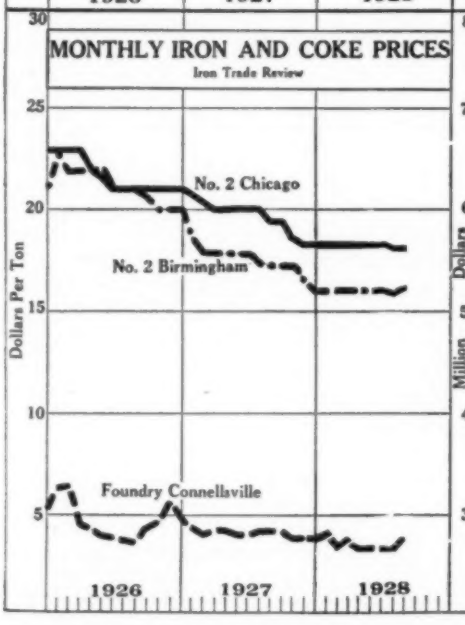
SUMMER slack, usually held to be unavoidable in the foundry industry missed fire in 1928. With August operations reported as holding up the previous high record of the summer months, and with continued activity during September, record production for the year seems in prospect. Automobile sales are headed for a record. Both production and orders for sanitary ware stand well ahead of last year. Steel foundry operations show signs of increase over 1927. Steel mill activity indicates that 1928 will go ahead of 1927. Building construction is holding its high record through the early fall. All of these signs indicate a continued strong demand for castings. The Ohio Foundries Association, Inc. reports August operations at 103.4 per cent of normal. Business conditions throughout the country tend to support the feeling of optimism which is expressed by castings manufacturers. Exceptional crops in mid-western and southern states are expected to bolster up the buying power of the rural sections. Sales of automobiles, miscellaneous farm machinery and household equipment in farm sections show improved conditions and a better outlook. Washing machine manufacturers, a number of which are large users of castings report September sales running ahead and August, 1928. Brass foundry operations are sustained by a continued demand from the great amount of building under way.

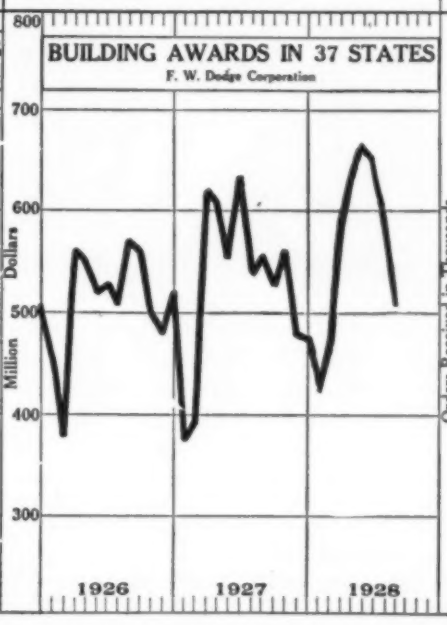
RAW MATERIAL PRICES
Sept. 22, 1928

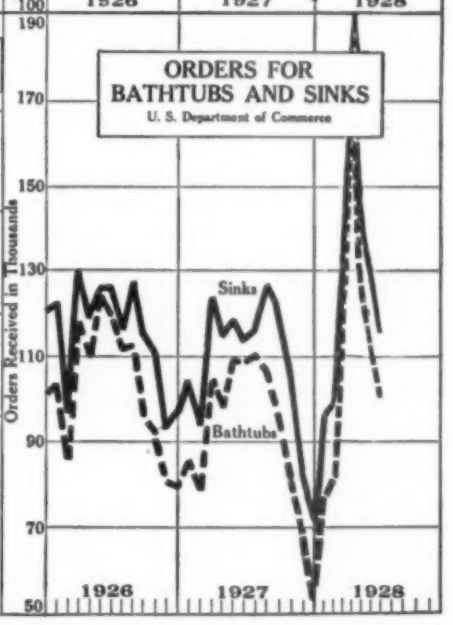
Iron	
No. 2 foundry, Valley	$17.00
No. 2 southern, Birmingham	16.25
No. 2 foundry, Chicago	18.50
No. 2 foundry, Philadelphia	20.26 to 20.76
No. 2 foundry, Buffalo	17.50
Basic, Valley	16.25 to 16.50
Basic, Buffalo	17.00
Malleable, Chicago	18.50
Malleable, Buffalo	18.00
Coke	
Connellsville foundry coke	$3.75 to 4.85
Wise county foundry coke	4.50 to 5.25
Scrap	
Heavy melting steel, Valley	$15.00 to 15.50
Heavy melting steel, Pitts.	16.50 to 17.00
Heavy melting steel, Chicago	13.00 to 13.50
Stove plate, Buffalo	13.75 to 14.25
Stove plate, Chicago	11.50 to 12.00
No. 1 cast, New York	13.00 to 13.50
No. 1 cast, Chicago	14.50 to 15.00
No. 1 cast, Philadelphia	16.00 to 17.00
No. 1 cast, Pittsburgh	14.25 to 14.75
No. 1 cast, Birmingham	13.00 to 13.50
Car wheels, iron, Pittsburgh	15.50 to 16.00
Car wheels, iron, Chicago	13.00 to 13.50
Railroad malleable, Chicago	14.00 to 14.50
Agricultural Mal., Chicago	13.00 to 13.50
Malleable, Buffalo	15.50 to 16.00
Railroad malleable, Pitts.	14.00 to 14.25
Nonferrous Metals	Cents per pound
Casting copper, refinery	14.50 to 14.62½
Electro copper, producers	14.90
Straits tin	48.87½
Lead, New York	6.50
Antimony, New York	10.37½
Nickel, electro	37.00
Aluminum, No. 12, producers	23.00
Aluminum, No. 12, remelt	15.50 to 16.00
Zinc, East St. Louis, Ill.	6.25











Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

E F. SCOTT, formerly connected with the Austin Co., Cleveland, was made secretary-manager of the Ohio Foundries Association, Inc., by the board of directors at a meeting held in Cleveland, Friday, Sept. 21. For the past six years Mr. Scott has been with the Austin Co. as engineering specialist in layout, design and equipment of foundries. His duties also took him into sales promotion and representative work. For several years Mr. Scott has devoted considerable time to the study of the problems of the foundry industry, including foundry layout and the design of equipment. Mr. Scott will take over the work of the Ohio State group on Oct. 1.

E. F. SCOTT

Fred H. Doolittle, formerly secretary-manager of the Apartment House Owners association, Cleveland, has been appointed central states representative for the Gray Iron institute. Previous to his work in organizing the Apartment House Owners, Mr. Doolittle was for three years membership secretary of the American Plan association, being selected for that work as a result of his accomplishments as personnel manager for the Telling-Belle Vernon Co., Cleveland. During the war Mr. Doolittle with the rank of captain was in charge of personnel work in the navy yards and arsenals in the East with headquarters in Boston. Mr. Doolittle's early life was spent in the town of his birth, Mishawaka, Ind.

Walter J. Kohler, president of the Kohler Co., Kohler, Wis., was nominated for governor of Wisconsin on the Republican ticket as a result of the primaries, defeating both Gov. Fred R. Zimmerman and Congressman James D. Beck.

Archer A. Landon, president of the Landon Radiator Co., North Tonawanda, N. Y., and formerly connected with the American Radiator Co., will supervise the Landon plants of the Crane Co., purchasers of the controlling interest in the Landon Co. Mr. Landon also will be in charge of the other plants which the Crane Co. plans to establish in other parts of the United States and Europe.

Albert Walton, Melrose Park, Philadelphia, has been appointed eastern representative of the Gray Iron institute with headquarters at Philadelphia. For a number of years Mr. Walton has been engaged in industrial engineering work and has had a broad contact with the metal trades in the eastern states.

ALBERT WALTON

R. P. Lamont, president of the American Steel Foundries, Chicago, has been appointed a trustee of the World's Fair Centennial celebration in Chicago in 1933.

Philip P. Miller has been appointed assistant superintendent of the Central Foundry Co. plant at Dundalk, N. Y. Mr. Miller was graduated from the U. S. Naval academy in 1922 and has been employed in various capacities by the Craig Foundry Co., 42 Sanford street, and Pratt institute, 215 Ryersaw street, both of Brooklyn.

L. C. Wilson, formerly president of the Federal Malleable Co., Milwaukee, has been made assistant to the president of the Interstate Iron & Steel Co., Chicago. Mr. Wilson secured his preparatory education in the schools of New Haven, Conn., and his technical training in the Sheffield Scientific school of Yale university, from which he was graduated in 1907 with the degree of B.S. in mechanical engineering. He then became connected with the sales department of the Harbison-Walker Refractories Co., and represented that company for several years in the Pittsburgh, Chicago, New York and New Haven, Conn., districts. Later he joined the staff of the Chain Belt Co., Milwaukee as assistant to the vice president and later as general sales manager. Transferring to the Federal Malleable Co. as secretary, he later was elected vice president and general manager then was made president. Mr. Wilson has been active in the work of the American Foundrymen's association. At the Detroit convention in 1926, he was elected a director

L. C. WILSON

of the association for the 3-year term. He also is chairman of the malleable casting section of the papers committee.

Lloyd McDumand has resigned his position with the Illinois Foundry Co., Springfield, Ill., to become connected with the pattern shop of the Walworth Co., Kewanee, Ill.

J. H. Messenger has resigned his position as foundry foreman with the Farrel-Birmingham Co., Inc., Ansonia, Conn., on account of ill health. Mr. Messenger was the guest of honor at a farewell party at which he was presented with a traveling bag and smoking jacket. He was formerly connected with Allis-Chalmers-Bullock Ltd., Montreal, Can., and Niles-Bement-Pond Co., Hamilton, O.

Address Detroit Group

Upon special invitation of the Detroit Foundrymen's association, Walter Seelbach, president, Arthur J. Tuscany, secretary and Fred H. Doolittle, central states representative of the Gray Iron institute attended the September meeting of the Detroit Foundrymen's association held in the Fort Shelby hotel, Detroit, Thursday evening, Sept. 20, with a dinner at 6:30 and the business meeting at 8 p. m. Robert Crawford, Atlas Foundry Co., Detroit, acted as toastmaster and introduced Fred Erb, Erb-Joyce Foundry Co., Detroit, and a director of the Gray Iron institute, Mr. Seelbach, Mr. Tuscany and Mr. Doolittle, who spoke on various phases of the work of the Gray Iron institute. Various members of the association expressed a great amount of interest in the work of the institute and offered their assistance in furthering the organization.

Due to the severe fire at the Forest City plant of the Forest City-Walworth Run Foundries Co., earlier in the week, Mr. Seelbach was detained in Cleveland until late afternoon of Sept. 20, when he took airplane passage, leaving Cleveland at 4:45 and arriving in Detroit at 6:15.

Establishes Prize Fund

Dr. Edward Goodrich Acheson, well known inventor of defloculated graphite, carborundum, and many other products, presented to the fifty-fourth convention of the American Electrochemical society, at Charleston, W. Va., held Sept. 20-22, a sum of $25,000 as a trust fund for the promotion of electrochemical research. This fund is to form the basis for an award every alternate year of a gold medal and a prize of $1000 to any man who has made a distinguished contribution to any of the branches fostered by the American Electrochemical society.

Obsolescence Discussed by Equipment Makers

The meeting of the Foundry Equipment Manufacturers association, held at the Hotel Cleveland, Cleveland, Sept. 18, was well attended. After reports by the members present on business conditions in the industry, a number of addresses were made. J. T. Keenan, treasury department, Washington, spoke on "Depreciation and Obsolescence of Shop Equipment from the Income Tax Standpoint," and A. E. Grover, cost consultant, National Machine Tool Builders association, Berea, O., talked on "Accounting for Depreciation and Obsolescence of Shop Equipment."

After the luncheon Glenn H. Hoppin, vice president, Stout Air Services, Inc., spoke on "How Foundry Equipment Manufacturers Can Use Airplane Service to Increase Sales," Walter Seelbach, president of the Gray Iron institute explained the work of that group and Arthur J. Tuscany, secretary, told how the foundry equipment manufacturers may co-operate with the institute to merchandise the foundry industry. On Wednesday, Sept. 19, a number of the members of the Foundry Equipment Manufacturers association journeyed to the Chagrin Valley Country club near Cleveland for a golf tournament.

Foundry Association Directory

American Foundrymen's Association

President, S. T. JOHNSTON, S. Obermayer Co., Chicago; secretary-treasurer, C. E. HOYT, 222 West Adams street, Chicago; technical secretary, R. E. KENNEDY, 222 West Adams street, Chicago.

Associated Brass Founders of New England

President, J. A. DUNCAN, Wm. Duncan & Sons Co., 166 Liverpool street, East Boston, Mass.; Secretary, LEROY P. ROBINSON, 141 Milk street, Boston. Meeting the fourth Wednesday of each month at the Engineers' club, Boston.

The Buffalo Foundrymen

President, J. MCARTHUR, Washington Iron Works; secretary, W. J. WARK, E. J. Woodison Co., 146 Chandler street. Meetings on third Wednesday of the month at 146 Chandler street.

Central Illinois Foundrymen's Club

President, H. M. HIRE, Hire Foundry Co., Peoria, Ill.; secretary, FRANKLIN WHITEHEAD, The Meadoms Mfg. Co., Bloomington, Ill.

Chicago Foundrymen's Club

President, DAVID G. ANDERSON, Western Electric Co.; secretary, ALBERT N. WALLIN, S. Obermayer Co., 2563 W. Eighteenth street. Meetings second Saturday in each month at the City club, 315 Plymouth court.

Connecticut Foundrymen's Association

President, FRED W. STICKLE, Capitol Foundry Co., Hartford, Conn.; secretary, C. S. NEUMANN, Union Mfg. Co., New Britain, Conn. Meetings are on second Friday of each month in various parts of the state.

Detroit Foundrymen's Association

President, J. J. BOLAND, Griffin Wheel Co., Detroit; secretary, ROBERT HOPE, Holley Carburetor Co., Detroit. Meetings third Thursday in each month at Webster hall, Cass and Putnam avenues, Detroit.

East Bay Foundrymen's Association

Secretary, H. L. MARTIN, Marchant's Foundry Co., 4401 East Tenth street, Oakland, Calif.

Gray Iron Institute

President, WALTER L. SEELBACH, Forest City-Walworth Run Foundries Co., Cleveland; Secretary, ARTHUR J. TUSCANY, Terminal Tower building, Cleveland.

Malleable Iron Research Institute

President, F. L. SIVYER, Sivyer Steel Casting Co., Milwaukee; secretary, ROBERT E. BELT, Union Trust building, Cleveland.

Metropolitan Brass Founders' Association

President, WILLIAM EMBER, Jefferson Brass Foundry, 62 Delevan street, Brooklyn, N. Y.; secretary, WILLIAM E. PAULSON, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 34 West Thirty-third street, New York.

Newark Foundrymen's Association

President, J. L. CARTER, Barlow Foundry Inc., Newark; secretary, W. H. MANTZ, Atlas Foundry Co., Irvington, N. J. Meeting called by president.

New England Foundrymen's Association

President, CHARLES F. MILLER, Universal Winding Co., Providence, R. I.; secretary, FRED F. STOCKWELL, 205 Broadway, Cambridgeport, Mass. Meetings second Wednesday of each month at the Exchange club, Boston. Outings usually are held in the summer months.

Ohio Foundries Association Inc.

President, C. C. SMITH, Toledo Steel Casting Co., Bancroft and Smead avenue, Toledo, O.; secretary-manager E. F. SCOTT, 5713 Euclid avenue, Cleveland.

Philadelphia Foundrymen's Association

President, WALTER WOOD, R. D. Wood & Co., Philadelphia; secretary HOWARD EVANS, Union League club, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

Southern Metal Trades Association

President, GEORGE B. COCKER, Gastonia, N. C.; secretary, W. E. DUNN JR., Healy building, Atlanta, Ga.

Pittsburgh Foundrymen's Association

President, W. P. BRADLEY, Wheeling Mold & Foundry Co.; secretary-treasurer WILLIAM J. BRANT, Wm. J. Brant, Bessemer building, Pittsburgh. Meeting on the third Monday of the month, except in July and August, at Fort Pitt hotel.

Quad-City Foundrymen's Association

President, A. D. MATHESON, French & Hecht, Davenport, Iowa; secretary-treasurer, HUGO WOLF, Frank Foundries Corp., Davenport, Iowa. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

Tri-City Technical Council

Chairman F. V. SKELLEY, Tri-City Railway Co., Rock Island, Ill.; treasurer, MAX SKLOVSKY, Deere & Co., Moline, Ill. Combined meetings held only one or two times a year on call.

Tri-State Foundrymen's Association

President, HAROLD P. RITTER, John A. Oberhelman Foundry Co., 3323 Colerain avenue; secretary, GEORGE W. PIEHL, Wessling Bros. Foundry Co., 1607 McLean avenue. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

Twin City Foundrymen's Association

President, H. H. NOTT, Smith System Heating Co., Minneapolis; secretary-treasurer, C. E. LANGDON, 3849 Lynda'e avenue, south, Minneapolis. Meetings monthly at the Athletic club.

Washington Foundrymen's Club

President, RONALD KUCHER, Olympic Foundry Co., Argo Station, Seattle; secretary, EDWARD C. GUSTIN, The Prescott Co., 1 West Lander street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.

Break Ground for New Shovel Plant

TWO great-great-great granddaughters of Oliver Ames, who in 1802 took over from his father, Capt. John Ames, the shovel works founded by the latter in 1774, helped break ground, Aug. 29, for the new blade factory of the Ames Shovel & Tool Co., North Easton, Mass. The structure, to be one-story, 60 x 400 feet, of reinforced concrete, will enable the company to rearrange operations in the present plant at North Easton. Officers of the company, directly in the rear of the children, are Samuel S. Early, assistant to the president; A. H. Daggett, treasurer; W. B. Hopkins, director; Richard Harte, director, and William A. Ready, president.

Portable Machine Makes Medium Sized Molds

The Osborn Mfg. Co., 5401 Hamilton avenue, Cleveland, recently has introduced two portable type molding machines designed for the production of medium sized molds. These machines may be used in pairs, the jolt, rollover, pattern draw machine being designed for the production of drag molds and the jolt, stripper machine for making cope molds. The two machines may be moved along ahead of the completed molds so that the carrying distance is small.

The jolt, rollover, pattern draw machine, shown in Fig. 1, has a rollover table cast of an aluminum alloy. The swing out table rotates in extra long phosphor bronze bushings. The squaring shaft is built of one piece, providing permanent alignment for the pattern draw. The main frame is a semisteel casting and the jolt table is a semisteel casting with strengthening ribs. Renewable bushings are provided at all wearing points. Adjustable clamps are provided and one lever locks the four point leveling mechanism. One disk type valve controls all the power operations of the machine and a safety valve prevents jolting while the swing frame is over the jolt table. The leveling bars engage practically any design of bottom board.

The jolt, stripper machine, shown in Fig. 2, is mounted on four large, wide-faced wheels. The jolt table has cutaway corners and has the effectiveness of a table 20 x 22 inches, permitting the mounting of any pattern within the capacity of the machine. The lifting pins are adjustable in height for different thicknesses of pattern plates and also adjustable from 16 to 24 inches in length and from 12 to 18 inches in width. Wood or metal pattern plates may be used. The pattern draw lever is located conveniently and a vibrator valve is secured to the handle.

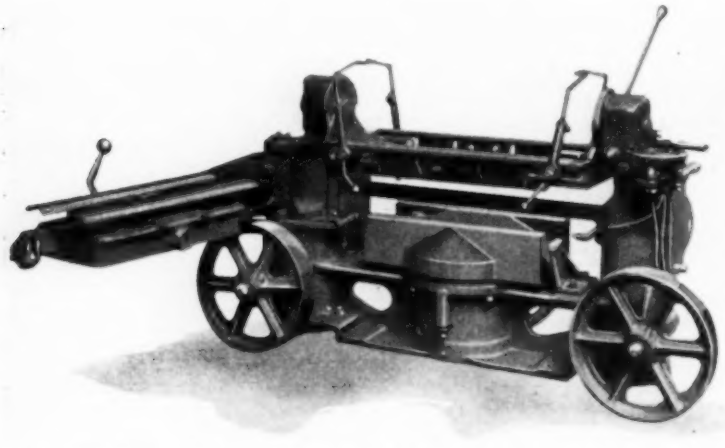
Group Changes Name

The Ohio State Foundryman's association has been incorporated under the name of The Ohio Foundries Association, Inc. The officers, elected at a recent meeting are: C. C. Smith, Toledo Steel Casting Co., Toledo, O., president; D. McDaniel Hamilton Foundry & Machine Co., Hamilton, O., vice president, and E. Sands, Superior Gas Engine Co., Springfield, O., treasurer. E. F. Scott has been appointed secretary-manager of the organization and will assume his duties Oct. 1.

Will Meet in Pontiac

The October meeting of the Detroit Foundryman's association will take the form of a special trip to visit the plant of the Wilson Foundry & Machine Co., Pontiac, Mich. Members of the association will drive to Pontiac Thursday, Oct. 8, for the meeting.

W. E. Tierney has been appointed the south and southwest representative of the Botfield Refractories Co., Philadelphia, with offices in New Orleans. Mr. Tierney was graduated from Tulane University as a mechanical engineer.



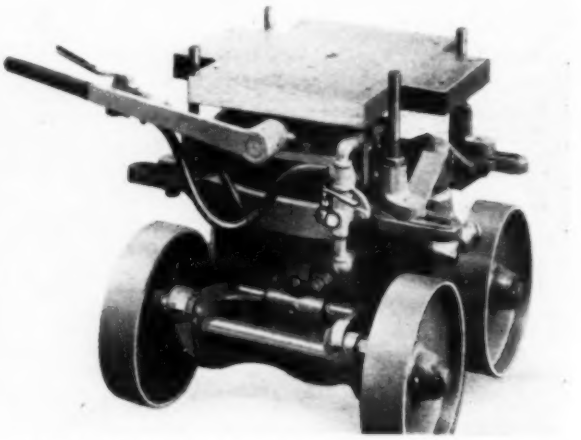


FIG. 1—THE ROLLOVER TABLE OF THIS MACHINE IS CAST OF AN ALUMINUM ALLOY. FIG. 2—IN THE JOLT, STRIPPER MACHINE, THE LIFTING PINS ARE ADJUSTABLE

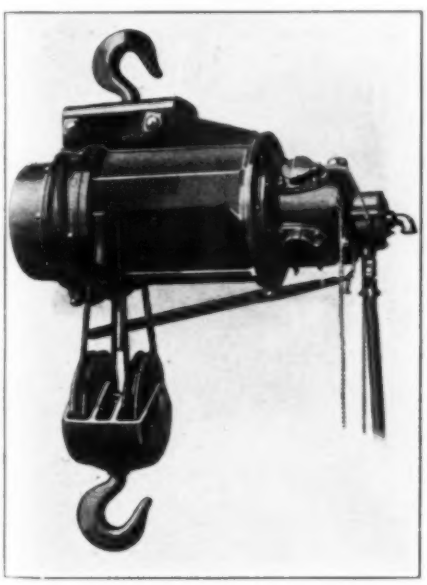
Makes Conveyor Idler

The Fairfield Engineering Co., Marion, O., recently has introduced a new type of belt conveyor idler. This idler is fabricated from centrifugally cast iron pipe which is claimed to be free from blow holes and slag pockets and of a uniform wall thickness. The cast pipe section also is highly resistant to rust and abrasion. Roller bearings are used throughout and direct high-pressure type lubrication is employed. Bearing adjustment is positive, with any degree of fineness. Heavy cast iron brackets which hold the idler in place are mounted on a self-cleaning angle base. If desired, bases may be supplied which should tilt the idler in the direction of belt travel to insure a true running belt.

Air Hoist Is Built With Four Cylinder Motor

The Ingersoll-Rand Co., 11 Broadway, New York, recently has introduced a new air hoist having 20,000 pounds capacity. The hoist construction employs a powerful, 4-cylinder, air motor geared to a rope drum and all enclosed in a compact housing designed to prevent the entrance of dirt. The gears are made of special steel and operate in a bath of semifluid grease. The bronze bearings or ball bearings are provided at all points where experience has shown that this particular type of bearing will add to the efficiency and the life of the hoist.

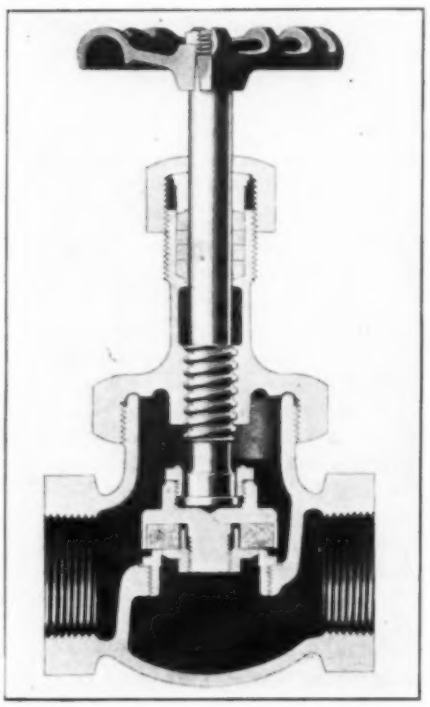
An automatic brake of similar design to that used on other hoists manufactured by the Ingersoll-Rand Co., is incorporated on the new hoist. This safety brake automatically holds the load at any desired pressure. Instant and complete control of the hoist movement is obtained by a graduated throttle. The cylinders are renewable and interchangeable. The hoist may be supplied with either a top hook or a chain driven trolley as standard.



AN AUTOMATIC BRAKE IS INCORPORATED IN THE MACHINE

Builds Pressure Valve

Jenkins Bros., 80 White street, New York, recently introduced a new line of bronze valves with renewable disks for 250 pounds steam working pressures. The line comprises globe, angle, cross and horizontal and angle check patterns, furnished screwed or flanged, in sizes ranging from ¼-inch to 2 inches. The globe, angle and cross patterns are supplied with renewable seat rings. A bonnet screws over the body and the bonnet seat joints are rounded to provide strength and to permit the bonnet to be removed easily. Other features of the globe include the nonheat hand wheel of malleable iron, a bronze gland to prevent leakage around the spindle, a deep stuffing box and a manganese bronze spindle.



STRENGTH IS A FEATURE OF THE VALVE CONSTRUCTION

Measures Energy Emitted

The Colonial Supply Co., 217 Water street, Pittsburgh, is introducing a new development of the total radiation type pyrometer. The fundamental principle on which this pyrometer operates is the measurement of the total radiant energy emitted by a hot body whose temperature is to be determined. The theoretical relation between the temperature of the black body and the radiant energy emitted by it, is given by the Stefan-Boltzmann law, in accordance with which the radiant energy at any particular temperature is a direct ratio of the fourth power of the absolute temperature of the perfectly black body.

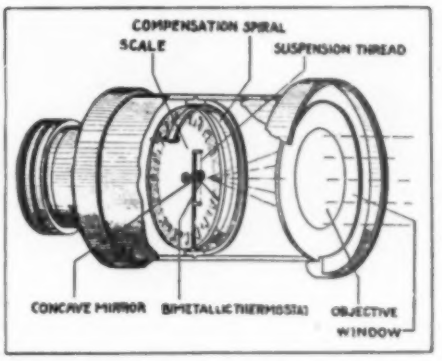
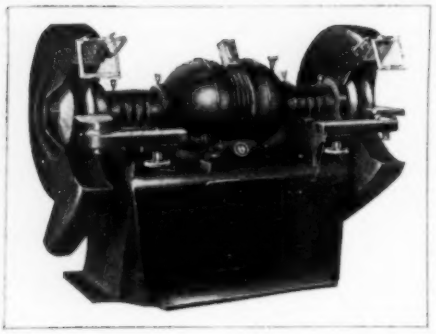


DIAGRAM SHOWING FEATURES OF RADIATION PYROMETER

A bimetallic spiral of about 0.1-inch diameter and 0.001-inch thickness is located at the focus of a collecting lens having a diameter of 1⅛ inch and a 2-inch focal radius. A pointer, joined to the spiral, which moves in front of the scale divided in temperature degrees, permits the operator to observe the change of the spiral. To obtain the highest possible sensitivity of the instrument, the spiral is fastened to a stretched wire 0.002 inches in diameter. A small concave mirror is set behind the wire. To compensate for variations in room temperatures, the scale can be turned and its momentary position relative to the pointer regulated automatically by a compensation spiral. The scale is transparent and can be seen at the same time the glowing surface is viewed. A red glass is provided to protect the eye against bright rays when measuring high temperatures. All working parts are completely enclosed and protected in a dust proof housing. The accompanying illustration shows a sketch illustrating the various important parts of the instrument.

H. H. Sherman recently was appointed manager of the publicity department of the Chicago Pneumatic Tool Co., with headquarters at the general offices of the company, Chicago Pneumatic Tool building, 6 East Forty-fourth street, New York. Mr. Sherman joined the company in 1927 as assistant publicity manager and has had many years' experience in advertising work.



THE MACHINE IS EQUIPPED WITH SAFETY DEVICES

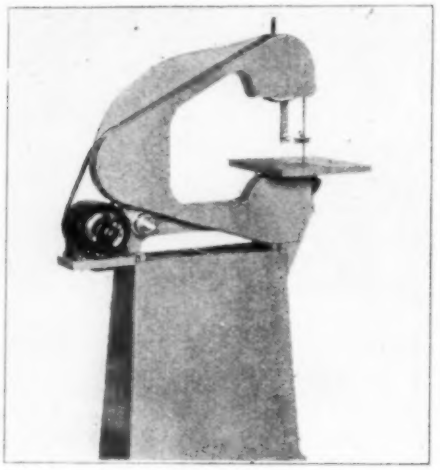
Grinding Machine Runs at High Speeds

The United States Electrical Tool Co., 495 West Sixth street, Cincinnati, recently has introduced a new machine designed for high-speed grinding and snagging. A speed of 9500 surface feet per minute may be attained on this machine with wheels 30 inches in diameter. When the wheel is worn down to 24 inches in diameter it travels at 7500 feet per minute. This makes the average speed of the wheel 8500 surface feet per minute. On 25 and 60-cycle circuits, 24-inch wheels with 2½ or 3-inch face and a 12-inch hole are recommended. These wheels will give a speed of 9300 surface feet per minute. The machine is supplied for 220, 440, 550 volts, 2 or 3 phase alternating current, and 220 volts for direct current.

The motor is a 15-horsepower unit designed for heavy duty service. The wheel flanges are keyed to the shaft and clamped securely to the wheel by cap screws. Steel safety hoods over the wheels are built for wheel speeds of 10,000 surface feet per minute. Doors on the safety hoods are fastened on by cap screws.

Band Saw Is Guarded

The De Walt Products Co., Leola, Pa., recently has introduced a portable type bandsaw designed to provide the power and handling capacity of a stationary type machine. The machine is guarded by a one cover hinge to the casting which houses the three tracking pulleys and the saw blade. This cover protects all of the saw blade with the exception of a small portion at the cutting point. The use of three tracking pulleys to separate the two sections of the revolving saw blade permits a compact design with 20-inch clearance in the throat between saw blade and frame. The machine has a capacity for material up to 7 inches in thickness. The entire machine including floor standard and motor weighs 210 pounds. Without the motor and floor standard the machine weighs 120 pounds. The working table is 13⅝ inches square and tilts at 45 degrees right and 30 degrees left.



THE SAW HAS THE CAPACITY OF A STATIONARY TYPE MACHINE

Grinds Several Cores in One Operation

Stoney Foundry Engineering & Equipment Co., 5101 Lakeside avenue, Cleveland, has introduced a new type of core grinding machine designed to grind a number of cores in one operation. As may be noted in the accompanying illustration the device consists of a frame which supports the core to be ground and the motor driven grinder. The grinder is carried on a special carriage with wheels fitted with ball bearings. The length of travel of the grinding wheel is 3 feet, the diameter of the wheel is 12 inches, the minimum height between the table and the bottom of the wheel is 4 inches and the maximum height is 6 inches. However, spacers may be used if necessary to raise the maximum height to 10 inches. The adjustment graduation is 0.005-inch

A fixture similar to that used in hand filing is placed on the table of the machine to support the cores.

Regulator Controls Gas

The Alexander Milburn Co., 1416 West Baltimore street, Baltimore, recently has introduced a new regulator designed for operation for a large volume of gas where a great number of outlets are to be controlled. The bonnet is of sturdy bolted construction and a safety blow-off valve is provided. The diaphragm extends to the outer circumference of the regulator and is secured by the same bolts which secure the bonnet. The regulator is equipped with 3000-pound initial gages and 500-pound delivery gages. The floating operating pin is monel metal and the diaphragm is a special bronze both of which are resistant to corrosion. An 8-inch heavy steel key affords leverage for the highest pressures. The regulator is readily accessible. The user may reach the seat without disconnecting it from the bottle or hose. The main operating parts, consisting of the pin, nozzle and seat-carrying sleeve, may be examined, cleaned or removed easily. The spring closes the seat with a pressure of several pounds.

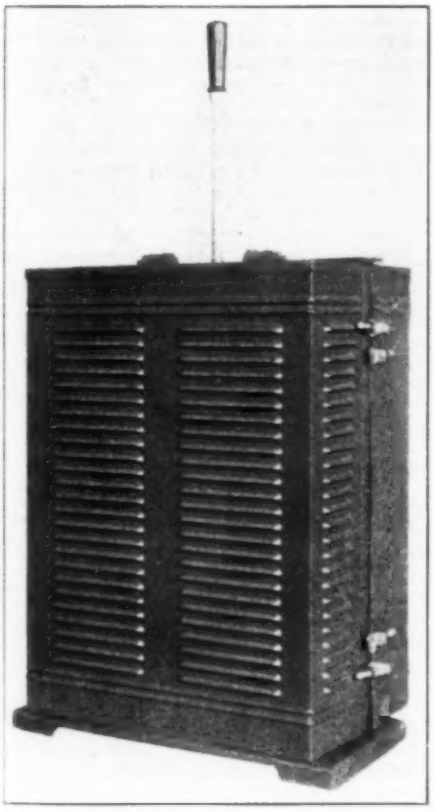
THE GRINDER IS CARRIED ON A SPECIAL CARRIAGE WITH WHEELS FITTED WITH BALL BEARINGS

Open Oxygen Plants

Four new plants recently started production of oxygen for the Linde Air Products Co., and now are serving the local demand in their respective localities. On July 3, a plant at 631 South Seventeenth street, Harrisburg, Pa., started operating in charge of J. J. Naber. A plant at Seventeenth and West Lawrence streets, Allentown, Pa., in charge of W. Berber, began production on July 18. On Aug. 1, the Shreveport, Pa., plant, located at Foster and Thomas streets, in charge of F. T. Rueger, started operating. Last of all, a plant First avenue and B street, South Charleston, W. Va., was added to the chain. Ed Pohlman is superintendent at the latter plant, which started manufacturing Aug. 10. The opening of these plants brings the total up to 52 oxygen producing plants operated by this company throughout the country.

Nickel Alloy Resistors Used on Controller

The Electric Controller and Mfg. Co., 2700 East Seventy-ninth street, Cleveland, has announced a new type controller, which involves several new features. This controller has an ebony asbestos dial, and the contacts are well ventilated. The contact supporting-lugs are attached to the front of the dial and are removable from the front. A single, square-head, cup-pointed, set screw is used in each terminal-lug to clamp the lead wire tightly. The bearing casting not only supports the main and quadrant bearings, but also supports the asbestos dial, permitting the contact fingers always to rotate in a plane parallel with the contact segments. Nickel alloy resistors are one of the outstanding features.

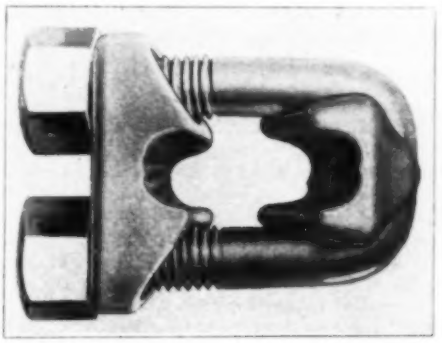


HAS ASBESTOS DIAL

EACH STAR HAS EIGHT POINTS AND TWELVE CLEANING EDGES

Builds Cable Clip

A plate cable clip having an exceptionally large holding surface recently has been placed on the market by the Eureka Metal Products Corp., North East, Pa. As shown in the accompanying illustration the large surfaces of both the top and bottom plates are grooved for the lay of the cable, so that neither of the cables is gripped by the U-bolt. The clip's double grooved surface prevents any distortion of the cable, no matter how tight the nuts are pulled down. The clips are made in all sizes and of either steel or bronze.



THE PLATES PROTECT THE CABLE

Makes Foundry Stars from Twisted Steel

The Franklin Core Rod & Gagger Co., Franklin, Pa., recently placed on the market a line of foundry stars made of twisted steel. In the manufacture of these stars, 0.5 to 0.6 per cent carbon steel in a square bar is twisted fairly uniformly so that one turn is secured to every 10 diameters. These twisted bars are moved automatically in successive positions under the cutting shears through fixed square openings only slightly larger than the section being cut. These fixed square openings located immediately in the rear of the stationary shear blade give the twisted bars a slight turn as they are fed forward. The bars are moved under the cutting blade at an angle to make the cut successively at right angles to one of the spiral corners of the twisted bar. This method of processing makes each successive face out of parallel.

The general shape of these stars provides eight points and 12 cleaning edges. It is claimed that the stars, due to their individual shape, react with one another in the tumbler into a twisting, twirling, scraping, cleaning mass, which cleans the work quickly. The stars are made in two grades, namely the standard or untempered and the tempered. The tempered stars show a hardness ranging from 45 to 58 rockwell machine. It also is claimed that the twisted stars do not scratch the castings and that they produce a good polish. The stars are made in the following sizes: ¾, 1, 1½, 2, and 2½-inch. The accompanying illustration shows the general shape of this type of foundry star, as well as the sharp points and the cutting edges.

Prepares Bibliography

A bibliography on effect of temperature on the properties of metals prepared by the joint research committee of the American Society of Mechanical Engineers and American Society for Testing Materials on the effect of temperature on the properties of metals has been issued as an American Society of Mechanical Engineers' research publication by that society. The bibliography is indexed chronologically (1825-1928) and by authors, and contains a subject index as well. A number of copies have been secured for distribution and are available upon application to the society's headquarters 29 W. 39th street, New York, at 75 cents per copy. A reduction in price is made for quantities over 100.

The executive offices of the Chisholm-Moore Hoist Corp., a division of the Columbus-McKinnon Chain Co. have been removed from Cleveland to Tonawanda, N. Y.

What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

Fisher Brass Co., Marysville, O., is building a plant addition to be used as a plating room.

Cadillac Malleable Iron Co., Cadillac, Mich., is extending its foundry and increasing the capacity of its annealing ovens.

Crane Co., Chicago, contemplates establishing a plant at Chattanooga, Tenn., for the manufacture of heating plant radiators of all types.

Crown Stove Works, 4631 West 12th place, Chicago, is in the market for sandblast equipment. J. C. Rogers is manager.

A 1-story foundry and machine shop, 100 x 280 feet is planned by Leubee Bros. Inc., Zanesville, O. John P. Schooley, Zanesville, O., is architect for the project.

Baker-Perkins Co. Inc., Saginaw, Mich., plans the construction of an addition to its Hess avenue foundry. It is scheduled for completion Jan. 1.

Meehanite Metal Wheel Co., Chattanooga, Tenn., has been incorporated with $25,000 capital by C. A. Noone, First National Bank building.

The Monroe Auto Equipment Mfg. Co., Monroe, Mich., is installed in its new plant. Production is increasing, having reached a capacity of over 15 tons daily.

Ouachita Iron Works, Monroe, La., M. W. Anthony manager, plans improvements, including a new foundry, machine shop, boiler shop, etc.

Sterling Bronze Co., East Twelfth street, New York, has moved its offices and factory to 23-10 Bridge Plaza South, Long Island City, N. Y.

Texas Electric Steel Castings Co., 1515 Spring street, Houston, Tex., has awarded the contract for a 1-story building to Lamella Trussless Roof Co.

Traylor Engineering & Mfg. Co., Allentown, Pa., plans to install power equipment in its new plant addition for manufacturing mining machinery.

Bethlehem Mfg. Co., Fountain Hill, Pa., has been incorporated with $10,000 capital by William A. Buss, to manufacture metal and wood products, including castings, tools, implements, etc.

Columbia Malleable Castings Co., Second and Linden streets, Columbia, Pa., L. R. Zifferer, president, has awarded the general contract for a 1-story foundry addition to J. H. Wickersham, 33 West Duke street, Lancaster, Pa.

Hayes Malleable Iron Co., 231 South LaSalle street, Chicago, has been incorporated with 4000 shares no par value stock to manufacture and deal in iron, steel and other metals by Maurice A. Riskind, Leroy Weis and Samuel A. Litman.

South Shore Mfg. Co., Elyria, O., is adding a gray iron and brass foundry and is planning to double manufacturing capacity. H. W. Wurst is president, R. F. Emsley vice president and G. B. Emsley secretary and treasurer.

The name of the Canadian Bronze Ltd., Box 160, Montreal, Que., has been changed to the Montreal Bronze Ltd., with offices at 999 Delorimier avenue, Montreal, Que., Can.

The foundation for the new foundry of the Appleton Machine Co., South Oneida street, Appleton, Wis., is complete. Workmen will start excavating for the casting pits soon.

Beach Foundry Ltd., Ottawa, Ont., will make a public offering of 7 per cent cumulative preferred stock, the funds from which will be for plant improvement and to finance its increasing business. The company manufactures stoves, ranges, heaters, furnaces, etc.

Homestead Valve Mfg. Co., Homestead, Pa., has bought a plant near Coraopolis, Pa., and will move its offices and manufacturing operations there. The purchase includes 108 acres, a three-story concrete factory building, office building, separate foundry building, pattern shop and storage, garage and oil storage.

Rockford Malleable Iron Works, Rockford, Ill., is making extensive additions to its plant. Several months ago this company was merged with the Northwestern Malleable Iron Co., Milwaukee, to form the Rockford Northwestern Malleable Corp. Northwestern Malleable Iron Co. is moving its plant and offices to Rockford in the near future.

Bingham & Taylor Corp., has been incorporated to take over the foundry of W. P. Taylor Co., 575 Howard street, Buffalo. This plant has a capacity of 150 tons per day of steel and iron castings. In addition to the manufacture of the aforementioned products the new company will manufacture alloy castings of steel, bronze and nickel for chemical work. (Noted July 1).

The New Home Sewing Machine Co., Orange, Mass., the Free Sewing Machine Co., Haddorff Piano Co., Landstrom Furniture Corp. and Rockford Book Case Co., Rockford, Ill., have been merged as the Consolidated Industries Inc. Oscar E. Landstrom is president, Armer E. Johnson and D. J. Fitzgerald, vice presidents, L. I. Johnson, secretary, and M. M. Murrell, director in charge of sales. Plants will be maintained at Rockford, Ill., Orange, Mass., and Williamsport, Pa.

New Trade Publications

PATTERN SUPPLIES—Wellman Products Co., Cleveland, has issued a catalog of patternmakers' supplies and equipment, covering a large line.

ALLOY CASTINGS—Sivyer Steel Castings Co., Milwaukee, in a current bulletin calls attention to its method of making alloy steel of the proper analysis in the furnace rather than in the ladle.

REFRACTORIES—Laclede-Christy, St. Louis, in a current bulletin show views of many typical installations using its fire brick. A feature of the bulletin is a comparison of Cent. and Fahr. temperatures.

CUPOLA CHARGERS—The Whiting Corp., Harvey, Ill., has prepared a folder showing the construction of its new type of cupola charging equipment. With this equipment the charging bucket is held in the cupola by a supporting casting and the bottom is allowed to drop.

HEAT TREATMENT—In a current bulletin the Stanley P. Rockwell Co., Hartford, Conn., discusses the importance of time control in heat treatment where distortion is detrimental. An illustrative example is taken and the result of following the company's plan is described.

SANDS, CLAYS AND REFRACTORIES—Algernon Lewin Curtis, Chatteris, England, recently has published a folder listing the various sands, clays, and refractories which his company distributes. A list of customers also is given.

ARC WELDERS—Fusion Welding Corp., Chicago, has issued a folder describing its line of welding machines. Text and photographs explain and illustrate the usefulness, design, etc. The back page of the folder presents general specifications for the electric motor generator units and the gas engine driven units.

NICKEL CAST IRON—International Nickel Co., New York, has issued the fourth of its series of bulletins on the general subject of insuring dependable properties in gray iron castings by the use of nickel as an alloy. The current bulletin has for its subject increased hardness. Microphotographs illustrate the text.

WELDING—The influence of manganese in steel welding rods is discussed in a bulletin by the Fusion Welding Corp., Chicago. The bulletin describes a portable welder driven by a gas engine which may be towed by an automobile to any location. It is mounted on rubber tired wheels and is self-contained.

CAST IRON—Whiting Corp., Harvey, Ill., is publishing a series of technical articles on cast iron and its manufacture. They are written by Dr. Edward E. Marbaker of the Mellon Institute of Industrial Research, Pittsburgh. The first bulletin is on high test iron and will be followed by other subjects of interest to the foundryman, such as cupola practice, sands, etc.

LIGHT AND VENTILATION—A new folder has been issued by David Lupton's Sons Co., Philadelphia, illustrating and describing its methods of obtaining proper lighting and ventilation in foundries. The folder is illustrated with photographs of typical installations and several sketches showing the theory underlying them.

MANGANESE STEEL—American Manganese Steel Co., Chicago, has issued a 20-page, pocket-size booklet containing information on manganese steel. It gives a short history of the development of manganese steel, its advantages, and many of its uses. Recommendations from several customers is also included.

CRANES—The Cleveland Crane & Engineering Co., Wickliffe, O., has issued a 16-page catalog illustrating and describing arc-welded, roller-bearing crane. The mechanical details and construction are illustrated with many of the parts. A description of a tramrail system and an installation also are shown. A list of illustrations of hook attachments is included at the end of the catalog.

ELECTRICAL EQUIPMENT—Recent bulletins of the General Electric Co., Schenectady, N. Y., describe direct current crane and hoist motors, totally enclosed motors for portable hoists, squirrel cage induction motors, direct heat electric furnaces, magnetic reversing switch for single phase, two phase and three phase motors, and a magnetic switch for alternating current motors.

PUMPS—Ingersoll-Rand Co., New York, in a current bulletin calls attention to its multistage centrifugal pumps. They are designed for modern high-pressure boiler feeding, hydraulic service in steel mills, mine drainage and pipe lines. Actual installations supply the illustrations. Details of construction are shown and the text covers operation.